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THE AMERICAN GAS LIGHT JOURNAL

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[OFFICIAL NOTICE.]

OFFICE AMERICAN GAS LIGHT ASSOCIATION,
142 CHAMBERS STREET, NEW YORK.

To the Members of the Association:

The VIII. Annual Meeting of the Association will be held in the city of Chicago, on the 13th, 14th and 15th days of October next.

Headquarters have been secured at the Grand Pacific Hotel, with a uniform rate of board for members at $2.50 per day. The meetings will be held in the large hall of the hotel.

The present indications point to an unusually interesting and instructive meeting. A full attendance of members is earnestly urged. Members who intend to present papers, and have not yet notified the Secretary to that effect, will please do so at an early date.

In order that the Committee of Arrangements—E. T. Watkins, President Chicago Gas Light and Coke Company, chairman—may be informed of the number who will be present at the meeting, and provide for the comfort of all, each member who expects to attend will confer a favor by notifying this office of that fact at as early a day as possible.

Officers of gas companies who are not members of the Association will find it to their interest to take advantage of the approaching meeting and send in their names for election as members. Blank applications may be had at any time at this office, or in Chicago during the sessions of the Association.

Efforts are being made to secure excursion rates for members who can start for Chicago from this city, due notice of which will be given when a decision has been reached by the railway managers.

WM. HENRY WHITE,
Secretary.

[OFFICIAL NOTICE.]

OFFICE OF CENTRAL N. Y. GAS ENGINEERS' ASSOCIATION,
August 27th, 1880.

The regular semi-annual meeting of this Association will be held at Bradford, Pa., on the third Wednesday of September (the 22d). Headquarters at the St. James Hotel.

C. A. WHITE,
Secretary.

THE WINTER'S PROSPECTS.

As the season advances the prospects for a return of better times than have been experienced for several years are exceedingly good. In some places, it is true, that the gain over last year is smaller than in others; but we believe that it is perfectly fair to state that the downward turn has fully stopped, while in many cases the improvement is very marked. The main cause to which the prospects or an increased send out this winter is due, is undoubtedly the general improvement in all kinds of business. There is no better barometer of the condition of business in general than the sales of illuminating gas. For while, on the one hand, the dullness of trade and manufactures inevitably produces a closer economy in every expenditure, including a closer watchfulness of the hours and amount of burning, on the other hand an increase of life in general trade brings more than its proportionate increase of consumption.

In this city all the companies are probably sending out over fifteen per cent. more gas than they were a year ago; but this is not all increased profit, for there has been an increase in the cost price of coal and labor. Last year coal was probably at an abnormally low figure. The prices here to-day are about as follows:

For standard Pennsylvania coals, about $5.00; the Province coals, about $3.75 or under; cannels from West Virginia, about $9.50.

There appears to be no reason why these prices should advance materially, for, at the ruling rates of freights, good English coals can be laid down at four dollars and a-half for caking, and nine and a-quarter to nine and a-half for good cannel coals.

The prospects of foreign trade do not indicate any great advance in foreign freights, so that the price of foreign coals, both caking and cannel, is likely to have some influence in the establishment of prices here for our domestic coals. The advance in the price of standard coals last spring had a tendency to cause a somewhat extended trial of other coals which were offered at lower prices, for the purpose of determining their relative values for gas

making purposes. In some instances these trials have resulted satisfactorily, and have shown the gas makers that they are not absolutely dependent upon any one source of supply, and that a judicious mixture of coals gives much better results in yield, candle power, coke and cost than had been obtained before, so that, in all probability, prices for coal will not materially change between now and next summer.

Another point of interest to many is the indication of a higher price for petroleum. By the carefully prepared reports which we have published from time to time, from *Stowell's Petroleum Reporter*, it will be seen that the oil district is becoming very clearly defined in extent, and that the indications as to production are pointing towards higher prices.

The quoted price for naphtha, in barrels, is ten cents a gallon, and, if reports are true, large lots, in bulk, are offered here at eight cents for immediate delivery, while orders for future deliveries are taken subject to prices to be fixed in the future. Whatever may be the cause that produces an increase in the price of oil, it must lead to an increased price for kerosene; and it is well known that, when dollars and cents are alone considered, cheap kerosene is the most formidable opponent that the gas business has to contend with. In dull times it is worse than in good times, for people put up with the inconvenience, the danger, and the poorness of light resulting from the use of oil either as a matter of real or supposed necessity. Another factor in the question is the price of anthracite coal for which $5 a ton is now charged here. This increases the value of the coke residual, and is bound to make an increased demand for it wherever anthracite is generally used; so that, from all sides, the net cost of manufacture seems to be reasonably fixed, inasmuch as the only other item which enters largely is labor, and at the rate at which emigration is going on there would seem to be no immediate danger of a dearth of laboring men.

One of the results of the enforced curtailing of business of the past few years has been the introduction of many economies in working, accompanied by an increased yield per ton of coal. This will undoubtedly continue, as the introduction of better furnaces, and mechanical means for handling coal, as well as for charging and discharging retorts, is more fully developed, so that the next five years ought to witness a considerable reduction in the price of gas to the consumer, and the increase of business that will result from this it is hard to calculate. The new uses to which gas will be applied for mechanical purposes have but just begun to manifest themselves, and every reduction in price is going to extend and develop these beyond all question. There is one part of the business in which it is barely possible there may be a large economy in the future and that is in the cost of distribution.

In the absence of any regularly published reports it is impossible to speak with accuracy on this point; but a published report of the Chartered Company in London, for the last six months, shows that the cost of manufacture, including cost of coals, salaries of engineers and officers at the works, wages, purification, and repairs and maintenance of works is to all other expenses as sixty-nine to sixteen.

From all the signs which appear, it would seem that a year of increased prosperity awaits the gas business in this country. The greatest load that the gas maker has to contend against is the amount of capital he is forced to pay dividends upon. Wherever this is excessive it should be reduced either by reducing the number of shares or by reducing the par value thereof. London is now lighted by five companies, thanks to amalgamation, and the result of their business for the year 1879 is as follows. We give the averages of the five companies—

Gas made per ton of coal	10,088	cu. ft.
Coke " "	41.43	bush.
Breeze " "	3.48	"
Tar " "	10.52	galls.
Ammoniacal liquor made per ton of coal	31.16	"
Capital and borrowed money " "	32.37	dollars.
Total income " "	10.50	"
Total expenditure " "	7.40	"
Gross profit " "	3.10	"

Of the expenditures the following are some of the items calculated to the ton of coal: Coals, including carriage, $3.75; purifying materials and labor, 20 cents; salaries and wages—manufacture—75 cents; wear and tear—works—$1.12; rents, rates, and taxes, six cents; collector's commissions, 10 cents; salaries and wages, wear and tear—distribution—60 cents; other expenses, 82 cents. Of the income $8.20 is from sales of gas, $2.10 is from the sales of residuals, leaving about 20 cents which is derived from meter rents, sale of old materials, and miscellaneous sources. The increase in the business of all the companies over the previous year amounted to about $1,236,000. From this it would appear that neither the electric light or petroleum had made any serious inroads on their business; so that the sixty millions of dollars invested in the gas business in London is not likely to be swept out of existence just yet. We feel equally certain that there is an immense future for gas in this country.

Result of Consolidation in London.

The close of the first half year's working of the greater South Metropolitan Gas Company—that young giant whose growth has received such marked impetus by the assimilation of its neighbors—is an event worthy of more than passing reference.

The results of the first half year's working of the three united companies now bearing that title, have been such as to testify in the most practical manner to the wisdom of the policy which brought about the act of union. We have on a former occasion expressed our appreciation of the spontaneous action on the part of the Directors in reducing the price charged for gas in the district of the late Phœnix Company to the level of that of the rest of the united district, six months earlier than they need have done in accordance with the provisions of the scheme of amalgamation. It may be taken for granted that when the report of the current half year is presented to the Proprietors of the late Phœnix Company's stock they will have as much reason as the consumers to congratulate themselves on the result of the reduction, as in all probability they will then receive 11¼ per cent. dividend.

It is not so very long ago that a dividend of 11¼ per cent. on Metropolitan or other gas stock—not under fortuitous circumstances merely, but as a regular thing—would have been regarded as impossible. If profits permitting such a division could be earned, it would have been said that the consumers would have risen in arms against being "robbed" to that extent, yet in the present case we see this high rate of dividend declared in broad daylight, based on accounts passed by an Official Auditor, and yet nobody complains. This is an evidence that a great change has come over the relations of gas companies (in London at least) and their customers. The consumers have learned that their interests are, by the action of the sliding scale, made identical with those of the gas manufacturer, and they therefore acquiesce in an arrangement which, although comprehended perchance by few, works for the good of all.—*Journal of Gas Lighting.*

The Petroleum Outlook.

The situation in the producing region has not materially changed since our last issue. The Triangle Well No. 3, noticed in a postscript as we went to press with our issue for the month of June, proves to be a 12 bbl. well, producing oil of about 38° gravity, which is considered by the trade too heavy for profitable refining purposes, and territory that produces 38° gravity oil is also considered small well territory.

Another well in the same vicinity, known as the Duke and Norton Well, was struck on the 11th of August, which is now producing oil of the same gravity as the Triangle Well, and will probably produce about the same amount per day. These wells have had a depressing effect upon the crude market for the past ten days; fears being entertained that they might prove to be an extension of the Bradford field, and thus add some 2½ miles of producing territory to it. However, it is now generally conceded that the gravity of the oil produced precludes the idea of any connection between the two points.

The production for the month, on the face of it shows an increase of some 2,000 bbls. per day, based on the pipe line runs from the wells during the month; but on a careful observation of the whole field, and an examination of the data necessary to make up our report, we are confident that the actual production has not materially increased for the past three months. Some months the runs from the wells evidently were less than the production, leaving a surplus, which is taken in the next month's run, together with the whole product for that month.

The prospect for an increase in production in the near future we do not consider good, as the new wells which have come in for the last three or four months have regularly fallen off in their average daily production, and the large amount of untested territory included in the great Northern Field (which is to-day perhaps the greatest bear on the market) must now be dr wn upon by the large number of wells at present in successful operation, and many of them for two or three years. We cannot account for the remarkable length of time the wells in that District have continued to produce bountifully on any other ground than that they have a very large extent of territory from which they are being supplied.

It would not be surprising to soon find that the reserve territory in this district has been completely drained by the wells which have been and now are so abundantly producing. If it should turn out otherwise, then this field will prove an exception to all other fields, especially so at Titusville, Pleasantville and in Butler County, where the choicest territory was reserved for the last to be drilled, and found, when drilled, to have the very best of sand, but to be completely drained of its oil.

The United Certificate Market, representing crude oil at the wells, for the month under consideration, averaged $1.06¼ per bbl. of 42 gallons each, which was 6¼ cents above the average price for the previous month.—*Stowell's Petroleum Reporter*, Aug. 16.

[From the "Review of Gas and Water Engineering."]

On the Cost of Working a Gas Engine Compared with the Same Work Done by Steam Power.

By Mr. F. T. Linton, Leith Gas Works.

Read at the meeting of the North British Association of Gas Managers at Perth.

It may perhaps be as well to explain that in the remarks which I have the honor to lay before you I do not propose going into any description of the principles of construction of the various gas engines now in the market. I have no doubt that the members are conversant with these already from the various communications of late years on the subject, and especially the very able paper read last year by Mr. Carr, of Halifax, before the British Association of Gas Managers.

My desire is simply to put before you what my experience has been of a gas engine which was erected at the works of the Edinburgh and Leith Gas Company in the spring of last year, and, as I suppose that my brother managers, like myself, are being frequently applied to for information and advice as to these engines, I thought that if I put together a few notes as to the cost of working our gas engine, with a comparison of the cost of doing the same work by steam power, it might be of some little service.

The engine is an Otto Silent Gas Engine, made by Crossley Brothers, of Manchester, and is of 3½ nominal horse power. It is employed to drive various machines in our workshops, such as a Root's Blower for three smith's fires, a large screw-cutting lathe, a screwing machine, a drilling machine, a circular saw, two smaller lathes, and two grindstones. The amount of power required varies considerably, as at one time nearly all of these machines may be in use, and at another time not more than two or three of them. In all cases, however, the smoothness and regularity with which the engine works is noticeable, there being no sensible diminution or acceleration of speed as the different machines are put in or out of action.

The attendance required is very slight.

The engine can be started in a minute's time, and the lubricating being done by an ingenious self-acting arrangement, no further attention is needed till the engine requires to be stopped, which is done instantly by shutting off the gas. The only other labor needed is to examine the slide valves once a week to see that the passages to the cylinder are clear, and this does not take more than from 15 to 20 minutes.

There is a water cistern in connection with the cylinder jacket, for keeping the cylinder cool, but I have found that the amount of water required after the first filling of the cistern is practically *nil*, as the temperature of the water has never risen so much as to require a stream of fresh water run in; the rest during meal hours and at night being sufficient for cooling the water down to the atmospheric temperature. Were the engine working continuously, however, as in driving an exhauster, a small stream of water would be necessary, and would have to be taken into account in estimating the expense of an engine for such a purpose.

The cost of the engine for the year from May 15, 1879, to May 15, 1880, working 57 hours per week, has been—

Gas for engine and slide lights, 99,000 c. ft., at 4s. 2d. per 1000 feet	£20	12	6
16 gallons of sperm oil for lubrication, at 3s. 6d. per gallon	2	16	0
Attendance, estimated at 1 hour per day, at 4d. per hour	5	4	0
Making total of working expenses	£28	12	6
The first cost of engine and cistern complete was £170, and the annual wear and tear may be taken at the rate of 7½ per cent., equal to	£11	18	0
Depreciation, the same	11	18	0
Making together	£23	16	0
Add to this working expenses as above	28	12	6
The total charge for year will be	£52	8	6

The amount of the working expenses would necessarily vary with the varying price of gas in different localities. What is given above was the selling price in Edinburgh and Leith last year, but of course the actual expense, where it is used in a gas works, will be not the selling, but the cost price of the gas. With regard to the percentages charged for wear and tear and depreciation, these are, I am sure, ample, looking to the well finished and substantial style in which those engines are got up, the absence of complicated working parts, and the large bearing surfaces of the parts liable to be worn out.

The amount of power derived from the above expenditure has been on the average at least two-horse power. As explained before, the use of several of the machines is intermittent, but it takes about 1½-horse power to drive those that are constantly in use, and the addition of ½-horse power to the average, for those that are used occasionally (including as they do a circular saw of large size and a heavy screw-cutting lathe) is a very moderate estimate. This works out to an expenditure of about seventeen cubic feet of gas per indicated horse power per hour, which is much below what is stated to be used when the engine is worked with a full load, and seems to bear out what was stated by Mr. Carr in his paper last year, that, contrary to what might be expected at first sight, the engine works more economically when not used up to its full power.

The cost of a steam engine and boiler of three and a half nominal horse power, and equal in respect to workmanship to the Otto gas engine, would be about £110; and the usual allowance for wear and tear and for depreciation would be 10 per cent. per annum for each on an engine and boiler of this size. This, relatively to 7½ for the gas engine, is not at all excessive, as of course the boiler involves more wear and tear and depreciation.

The working expenses would be—

To fuel, at 8s. per week for 52 weeks	£20	16	0
Wages of attendant, at 12s. per week	31	4	0
Oil for lubrication (same as gas engine)	2	16	0
Water supply for boiler	2	10	0
Making total working expenses	£57	6	0
Add for wear and tear, 10 per cent. on cost	11	0	0
And depreciation, 10 per cent. on cost	11	0	0
Making total charge for year	£79	6	0

It will be borne in mind that the cost of fuel will be more or less than that given above, according to locality; but it is a fair estimate, checked by actual experience of the working of a small steam engine and boiler in our works, and in comparison with what it costs various users of similar engines in the neighborhood. The wages of an attendant I have taken at 18s. per week, and I have allowed 6s. off that, on the supposition (which in many cases, however, could not be realized) that the man could devote so much of his time to other work.

The general results, then, are as follows:

Working expenses of gas engine	£28	12	6
Working expenses of steam engine	57	6	0

And, taking wear and tear and depreciation into account, the total annual charge would be—

For gas engine	£52	8	6
For steam engine	79	6	0

The advantage is therefore largely in favor of the gas engine, and I venture to think that if I have erred at all in the comparison it is in under, not over, estimating the cost of the steam engine. I have also to point out that our engine is constantly going during working hours. There are, however, an infinite number of cases where power is needed only at intervals, and in such cases the comparison would be still more in favor of the gas engine.

In all cases where we have supplied gas for these engines the testimony of the users has been highly in their favor, and not long ago one gentleman gave me his experience as being that:—"When he had a steam engine it cost him 18s. a week for wages to an attendant, and from 10s. to 12s. a week for fuel; but that now his cost was from 4s. to 5s. a week for gas, and no attendant needed."

In addition to the saving in cost, however, the gas engine has other advantages. It occupies small space; is always ready at a moment's notice; does away with the risk and danger of explosion, thereby reducing the cost of insurance to be effected in places where, with a steam engine and boiler, the companies would not undertake it. It also needs no special building, or chimney, and does not make the premises where it is used uncomfortable with heat, dust, and cinders.

One drawback it has, not as regards those who use it, but as giving trouble occasionally to gas managers, namely, that the action of the engine causes an oscillation of the lights taken from services immediately adjoining that of the engine, when the main pipe is small—say under 4 inches diameter. The supply should therefore always be taken from a large main where practicable, or, at any rate, where the main is less than 4 inches diameter no other service should be taken off in close proximity to that for the engine.

I had lately a correspondence with Messrs. Crossley about this, and they promised to send me a governor which is used on the Continent to prevent this oscillation, but it has not yet come to hand.

I may also note that the pressure in the main must be at least equal to that of seven-tenths of an inch of water.

That gas engines will ere long come into extensive use I think certain; not only as supplanters to some extent of steam engines, but also as affording a cheap and efficient motive power in a great number of places where the use of steam is difficult or impossible.

It is obviously the interest of gas companies and gas managers to forward their employment as much as possible, because they not only increase the consumption of gas, but, by using chiefly during the hours of daylight, no corresponding increase of capital expenditure is involved; and their extensive use would not only benefit gas manufacture, but gas consumers in general, by reducing the cost of making the gas.

[From the London "Journal of Gas Lighting."]

Lecture on the Past, Present, and Future of Coal Tar.

By Greville Williams, Esq., F.R.S., Etc.

Delivered at a meeting of the British Association of Gas Managers, Tuesday, June 8, 1880.

Mr. President and Gentlemen:—I have accepted with the greatest pleasure the invitation with which I have been honored by your Committee to deliver before you a lecture on the Past, Present, and Future of Coal Tar. The subject is so vast that it will be evident to you at once that each department will have to be treated with brevity, and my whole care will be to prevent that brevity from causing indistinctness or confusion. My hope is that what I have to say will at least present a sharp, clear outline, and with this intention I will define at starting what I mean by the Past, Present, and Future of Coal Tar. By the Past, I mean the history of coal tar previous to the great discovery of the aniline dyes made by Mr. Perkin. By the Present, I mean the discoveries made from that time until now; although I am compelled to include one or two observations of older date. In speaking of the Future of coal tar, I propose to call your attention to some of the ingredients of that substance, which, although of perfectly definite chemical constitution, have not yet been utilized, and are, in fact, thrown away.

In pursuance of this arrangement, I will ask you to just glance with me at the earlier researches which were made long before it was ever dreamed that coal tar would attain its present enormous and ever-increasing importance.

I think it may safely be said that the first cardinal discovery connected with coal tar was made in 1820, when Garden discovered naphthaline in coal tar oil; and yet naphthaline was destined to be one of the last of the coal tar hydrocarbons to be utilized. Even so late as 1866, when I wrote the article on "naphthaline" for Watts's "Chemical Dictionary," I remarked that great efforts had been made to find a use for it, but that none had been entirely successful, although lampblack was sometimes prepared from it by condensing the dense smoke which burning naphthaline evolves. I also said that efforts had vainly been made up to that time to prepare fast colors from it; but I also added that there was no doubt whatever that in a few years, perhaps months, the difficulties in utilizing naphthaline would be overcome. It needs not to be said that this prophecy (which required no great powers of prevision) has now been amply verified, as I shall show you latter on that the most superb colors are now produced from it; and, as I believe its uses will become greatly extended, and consequently its commercial value increased in proportion, I strongly recommend you no longer to regard as valueless the deposits you may meet with.

The next great discovery to that of naphthaline was made five years later—namely, in 1825—when the illustrious Faraday discovered benzole, or, as we now term it when pure, benzene. He found it in the liquids produced by the compression of oil gas, but it is also formed in a great number of chemical reactions. I shall have more to say about it presently. Seven years later—that is, in 1832—Dumas and Laurent discovered anthracene, which at one time was called paranaphthaline. For nearly forty years it remained a mere chemical curiosity; but now it is second in importance to none of the products of coal tar. In the same year that Dumas and Laurent discovered anthracene, Reichenbach discovered in wood tar a substance which he called creosote, and two years later—namely, in 1834—Runge discovered carbolic acid, which is known also by the names phenol, phenic acid, and coal tar creosote. The wood tar creosote and the coal tar creosote were for a long time considered as the same substance, but they are now known to be specifically distinct. In the same year that Runge discovered carbolic acid he also found aniline to exist in coal tar; the quantity is, however, so small that it cannot be profitably extracted, and that is why we always prepare it from benzene. The actual *discovery* of aniline was, however, made by Unverdorben, as I shall show presently.

The year 1834 was indeed a fruitful one for the chemistry of coal tar, for, in addition to his other discoveries, Runge obtained the first color reaction from coal tar, and this discovery was made in a very curious manner. You are all aware that one of the principal characteristics of ammonia is the fact that it gives white fumes when brought near a rod dipped into hydrochloric acid. Now Runge (who may be considered the father of the chemistry of coal tar) happened on one occasion to prepare some oils by distilling the tar, and he was desirous of ascertaining whether these oils contained any ammonia. A glass rod not being at hand, he dipped a slip of deal wood into hydrochloric acid, and held it over the oil, when it gave white fumes, indicative of the presence of ammonia or of volatile organic bases; but, to his surprise, the part of the wood which had been wetted with the hydrochloric acid turned to a deep crimson color. This reaction being unique, he knew at once that he had discovered a new and remarkable substance, and he gave it the name of pyrrol. Great efforts were made by himself and other chemists to separate this substance in a state of purity, but all failed. When, as a very young man, I entered the University of Glasgow, my lamented friend, Professor Anderson, having undertaken to isolate pyrrol, he confided the practical details of the work to me; and certainly few chemical pupils ever had a more interesting subject to work upon. It is enough here to say that the investigation was completely successful. Previously it had always been supposed that pyrrol was a gas possessing a most repulsive odor, but it turned out that instead of being a gas it was a liquid boiling at 133°C., its formula being C_4H_5N, and when perfectly pure, possessing a delightful fragrance somewhat resembling that of chloroform.

I have here a few drops of the very first specimen of pyrrol ever prepared in a perfectly pure state, and I believe that it is now the only specimen in the world of the first pure preparation; but, small as this quantity is, it is enough to make many thousands of experiments showing its wonderful property of coloring fir wood. I have tried repeatedly to estimate the minimum quantity necessary for the reaction; but to express this quantity we shall have to use numbers like those used by astronomers to estimate planetary distances.

I need hardly say that to make an experiment with so small a quantity of so precious a specimen is a task more fitted for the laboratory than for the lecture table; but I trust I shall succeed in making you all see it. Of course, if I used a pyrrol artificially prepared I could have made the experiment on a larger scale, but I venture to hope that you would prefer to see this particular specimen. I have here a small slip of fir wood. I shall just touch its point with pyrrol, and hang it in this glass with the aid of a card. I now touch another slip of wood with hydrochloric acid, and hang it by the side of the other slip, taking care that they do not touch. Now, although pyrrol boils at 133°C., and is therefore by no means a very volatile substance, the second slip (if the experiment be successful) will soon acquire a rich crimson color. As (although pyrrol can now be made artificially) you will never again see the experiment made with the first specimen ever prepared, I hope you will kindly forgive me for taking up so much of your time with it; but I confess I never see it without thinking of the past history of coal tar, of Runge, who was the first to see the reaction, and of Anderson, whose investigation of pyrrol marks one of the great eras in organic chemistry.

Runge, I ought to tell you, when he saw this reaction, prophesied that one day other beautiful and useful colors would be made from coal tar; but, unfortunately, he did not live to see its fulfilment, and, equally unfortunately, the peculiarities of pyrrol have hitherto prevented it from being anything more than a chemical curiosity. However, the resources of science are unlimited, and this reproach will one day be wiped away.

Three years after the discovery of pyrrol—that is to say, in 1837—Pelletier and Walter discovered toluene in the oils produced by the distillation of resin, and this discovery was only secondary in importance to that of benzene. It is not necessary, I am sure, to say that the coal tar colors are not contained, as such, in tar; but it is a remarkable fact that to this day there are many persons, even among those whose employments would lead one to suppose that they have at least some knowledge of organic chemistry, who believe that the colors on the table before me are extracted from coal tar. I even lately heard a person say, "Oh, I have often seen the coal tar colors in the tar itself; for when a drop of tar falls upon water you see the most beautiful tints as it spreads out." I had some little difficulty in explaining to my friend that the colors he saw were not the coal tar colors, but arose from the decomposition of light, in exactly the same way as we see in the soap bubble and the opal.

I have now given you a strictly chronological sketch of the history of the discovery of a few of the principal ingredients of coal tar. It is, of course, only a sketch; but I have endeavored to make it show the more salient features—the landmarks, as it were of the more important discoveries which have led to the present wonderful development of this branch of industry; and I only hope that in my endeavors to give you a sharp and definite outline I have not trespassed too much on your patience.

At this point I must somewhat modify my programme, and paying less attention to chronology, consider the steps by which the substances we have previously spoken of have become utilized. Let us, therefore, return to benzene, or benzole, as the crude article of commerce is usually termed. A partially purified product, containing, I believe, about 30 per cent. of pure benzene, is familiarly known in domestic economy under the name of "benzine-collas," and is used for cleaning gloves and removing grease. Its formula is C_6H_6, and its vapor is nearly three times heavier than air. I

hope to be able to show you this heaviness by an experiment. I heat a small disc of copper over the spirit lamp. I then place it at the bottom of a beaker, which contains a few folds of paper, to prevent the heat of the disc from causing fracture. I then pour a few drops of the hydrocarbon upon it. The heat will cause it to boil, and thus convert it into vapor. I then pour this vapor, just as if it were a liquid, into a second glass, taking care that no liquid accompanies it. Although apparently empty, you will see that on applying a light it inflames. Now, if the vapor of the benzene had not been very heavy, you will easily perceive that this experiment would have been impossible.

The great German chemist, Mitscherlich, found that benzene could be prepared in a very pure state from benzoic acid by distilling its lime salt; but it was reserved for Hofmann and his pupil, C. B. Mansfield, to show that the true source for the production of benzene on the large scale was from coal tar. Mansfield devoted the remainder of his life to the production of benzene on the large scale. Unhappily, however, his enthusiasm for discovery led to his death; for a small experimental still, with which he was working, catching fire, he endeavored to remove it in order to prevent the distruction of the building, and while doing so he became covered with the blazing liquid, and perished miserably, thus adding his name, like Gehlen and Scheele, to the sacred list of "Martyrs to Science."

The inflammability of benzene is such that it will even burn on water. There are many substances which possess this property, and even some which burn on mere contact with water. Thus, if I throw a scrap of the metal potassium on water, you see that it instantly inflames. If I now vary the experiment a little, by pouring some benzene on the water, and then throw a scrap of potassium in, you will see that the potassium inflames and sets the hydrocarbon on fire.

This property of benzene and other hydrocarbons to burn on water, and potassium to inflame on contact with it, has even been proposed for use in naval warfare; I trust, however, we shall not live to see the time when such satanic means of destruction will be resorted to.

Benzene boils at 80.8° C., or 178° Fahr., and at 0° C., or 32° Fahr., it freezes into a beautiful mass of colorless crystals.

In order to produce colors from benzene, the next step is to convert it into nitrobenzene. This is effected by treating benzene with concentrated nitric acid, in accordance with the equation—

$$C_6H_6 + H\,NO_3 = C_6H_5NO_2 + H_2O$$

It is therefore, in chemical parlance, nitrobenzene, or benzene in which *an atom* of H is replaced by nitryl or nitric peroxide. Nitrobenzene (or, as it is sometimes called in commerce, essence or oil of mirbane) is a heavy oily liquid, of a specific gravity of 1.1866, having a fragrant odor, almost exactly like that of bitter almond oil. It is extensively used for perfuming the common kinds of scented soap, but it is somewhat poisonous.

This production of nitrobenzene is only one more step toward the preparation of the first of the coal tar colors; so you see that the beautiful colors upon the table are not obtained without much labor; and indeed, in some of them there are thirty or forty operations to be gone through, some of them requiring very delicate manipulation, before the colors are obtained.

The next step is a most important one; this is the conversion of nitrobenzene into aniline, it is to the discovery that aniline can be produced in almost any quantities from the benzene of coal tar that we are indebted for an apparently endless number of colors, having not only every tint seen in the rainbow, but many shades never before seen by man. To convert nitrobenzene into aniline, the nitro-compound is treated in large iron cylinders with iron borings and acetic acid. The change takes place in accordance with the equation—

$$\underbrace{C_6H_5NO_2}_{\text{Nitrobenzene.}} + 6FeO + H_2O = \underbrace{C_6H_7N}_{\text{Aniline.}} + 3Fe_2O_3$$

This reaction was discovered by M. Bechamp in the course of a purely scientific research. If he had known the enormous commercial importance it was destined to acquire, and protected it, his patent would have been one of the most valuable ever taken out. Be pleased to remember that this discovery of M. Bechamp's was not the discovery of aniline itself, but of a new mode of preparing it. Aniline was really discovered, as I have said, by Unverdorben in 1826; he obtained it by distilling indigo, and I can well recollect the time when an ounce or two, prepared in this manner, would be preserved in chemical laboratories as precious specimens. Unverborden called what he had found in this manner—crystalline.

When Runge found traces of analine in coal tar, he did not know that the substance he had found was the same as the crystalline of Unverborden; all he knew was that coal tar oils contained something which colored fir wood wetted with hydrochloric acid a deep yellow. He also found that aniline in solution with water turned a dark purple with a solution of chloride of lime. This last reaction is remarkable, as chloride of lime, or bleaching powder, generally destroys colors instead of producing them, as we shall see when we come to magenta. Now Runge concluded from what he had observed that the substance which gave a yellow with fir wood and hydrochloric acid, and a purple with bleaching liquid, was a new substance, and he called it kyanol. It was reserved for Dr. Hofmann to discover that the crystalline of Unverdorben, the kyanol of Runge, and the aniline of modern chemists, were, indeed, the same substance.

Here is a specimen of pure aniline. It is an oily liquid boiling at 182° C. or 359.6 Fahr. Allow me to repeat myself a little, and to ask you to remember that coal tar itself contains only mere traces of aniline, and that it is never extracted from it directly, but is always prepared from the benzene of coal tar, as yielding infinitely more than could be prepared in any other way.

And now, having given you the history of this wonderfully prolific alkaloid, the parent of the colors you see on the table, and directly or indirectly of many others, we come to the history of the first color which it yielded that was of any commercial value. Mr. William Perkin had the idea that quinine could be prepared from aniline; but his experiments not succeeding, they drifted into other channels, and the idea struck him that the purple I showed you as being produced when chloride of lime is added to aniline could be fixed, and used as a dye. While at work on the subject he dissolved aniline in sulphuric acid, and added bichromate of potassium to the solution. In time a dirty looking precipitate fell down; he poured a little alcohol on the precipitate, a purple dissolved out. He boiled the feather of his quill pen in the solution, and it became dyed with a purple infinitely more brilliant than had ever been seen before. Mr. Perkin then made this color on the large scale; it met with an almost unparalleled success, and thus by his unaided genius he became the founder of the vast industry now known as the Aniline Color Trade, which, in its turn, has so immensely raised the value of coal tar.

Magenta.—I need hardly say that the revolution in colors produed by this discovery of Mr. Perkins's purple (or mauve, as he termed it) could not fail to set many chemists at work in the hope of discovering other colors from aniline.

The next step was made by Mr. Verguin, who, by boiling aniline with anhydrous tetrachloride of tin, obtained a superb crimson, which as much eclipsed the old crimson as the mauve eclipsed the old violets. This crimson is now known as magenta. Immediately numerous patents were taken out for new processes for making it; but that of Mr. Medlock, which consisted in treating aniline with arsenic acid, superseded all others. It was sold to a firm of manufacturing chemists, who greatly improved the process of purification, and made an enormous fortune by it. Now, 100 lbs. of coal yield about 5 lbs. of tar; this tar yields about two oz. of benzene, which in their turn yield about 1040 grains of aniline (say 2¼ oz. avoirdupois), and this aniline gives 207 grains of magenta pure and crystalline. This will dye 8 lbs. of wool a full deep shade, or would print 207 yards of calico of a medium closeness and depth of pattern; so that each grain of magenta will print one yard of calico.

The magenta of commerce is a salt, a hydrochlorate of what is called rosaniline. This rosaniline is a colorless base; I have here a solution of it. I add acetic acid to it, and you see that the color is instantly developed. The tinctorial or coloring power of magenta is so enormous that if a piece of paper be simply dusted with it, so as to leave an imperceptible trace of the powder on it, it will become dyed if moistened with alcohol. A solution containing only a millionth part of magenta is distinctly red. But although magenta has such great tinctorial power, it is easily destroyed by a minute quantity of solution of bleaching powder.

The color that magenta gives to silk is very brilliant and beautiful, but it requires a very correct taste in dress or decoration so to use it as to avoid vulgarity. By daylight it is a rich crimson, but by gaslight it appears almost scarlet. This difference of shade is easily shown, you see, by the aid of burning magnesium.

Blues from Magenta.—Now, although magenta is a finished product, it is also the raw material for the production of various other colors. If boiled with aniline under proper conditions, it forms beautiful blues and violets. The violets made in this manner are falling into disuse, but the blues made from magenta are still produced on an enormous scale. There are a vast number of them of different shades and qualities, but there is one whose properties are so remarkable that I shall show you an experiment with it which illustrates its chief peculiarity. It is what is called an alkaline blue—that is, it is dyed in an alkaline solution. Now, an alkaline solution of this blue is colorless, and the dyed fabric is also almost colorless; but when the wool or silk so dyed is dipped into a weak acid the color instantly appears. The blue dyed in this manner has the valuable property of not rubbing off—that is, if rubbed upon a white surface the latter does not become blued. It is proper to state that this blue was one of the many discoveries of Mr. Nicholson.

Greens from Magenta.—By heating magenta in its colorless or basic condition with iodide of methyl, it is first converted into a violet, and finally into a very lovely green, which has the property of appearing more beautifu l

by gaslight than in the daytime. Several other greens, of more or less similar character, are now made from methylaniline violet, and by the action of benzyl trichloride on dimethylaniline. The tinctorial power of this green will be seen by dusting a little on paper and pouring alcohol on it. I now come to the

Dimethylaniline Violet.—By treating aniline with chloride of methyl under pressure we obtain dimethylaniline, and by mixing the latter with sand or common salt and nitrate or chloride of copper and acetic acid, a mass is obtained which is spread on copper trays in layers 3 or 4 inches thick. If these trays are kept in a room at a temperature of from 60° to 90° C. they harden and assume a metallic appearance. When the maximum of violet is formed, which is easily ascertained in practice, the violet is extracted by water. The bluer shades are obtained by the action of chloride of benzyl on the base of the violet. These violets are now universally employed for all the richest shades on wool, cotton, or silk. Here is a piece of silk dyed with dimethylaniline violet. You are all aware that purples and violets appear much redder by artificial light than by daylight. I will now burn a piece of magnesium ribbon, which yields a light as pure as that of the sun, and you will see how much bluer it appears.

I have no time to enter into the theory of the constitution of these colors, or of the aromatic series, as to do so would require more time than I can devote to the whole of this lecture. Those who desire information on this most interesting subject will do well to study the Supplement to Watt's "Chemical Dictionary," and the *Berichte* of the Chemical Society of Berlin.

Eosine.—The beautiful pink color called eosine is produced from benzene by a long and somewhat complex process. The color on silk or wool is a beautiful pink, and it makes the most brilliant of all red inks; but it is, unfortunately, rather fugitive.

Azo-Compounds.—The azo-compounds may be said especially to represent the Present of the coal tar colors, as it is to them that the attention of modern chemists is particularly directed. It is to the admirable researches of Greiss that the great progress in this direction is mainly due. An "azo-compound," in its most modern sense, may be defined as one in which one atom of nitrogen replaces one of hydrogen.

When nitro-benzene is treated at a boiling heat with nitric acid we obtain meta-dinitro-benzene, and this by reduction with iron and hydrochloric acid gives what used to be called phenylene-diamine, but is now known as diamido-benzene; and this substance in solution, when treated with nitrite of sodium and hydrochloric acid, yields triamido-azobenzene, or Bismarck brown. This color, which is now made on a very large scale, is a valuable and fast color. The quantities of this coal tar product now used may be judged from the fact that one firm in three years made 160 tons! I now come to

Chrysoidine.—This color was discovered by Dr. Witt, in the endeavor to obtain a diamido-azobenzene, as, for excellent reasons, he expected it to prove a valuable color. Chrysiodine crystallizes beautifully, as you will see by this specimen. It gives a very fine color on wool, of a beautiful orange yellow shade, such as you see in this swatch. [The word "swatch" is used by dyers for any piece of silk, wool, or other material used to try the quality of any color either by dyeing or printing.]

Tropæolines.—The tropæolines are a further development of the azo-compounds, and can be obtained of all shades, from the palest orange to the deepest scarlet. Dr. Witt's tropæoline, OO, is one of the most beautiful of all the members of the series, and appears quite resplendent by the light of burning magnesium.

Naphthaline Colors.—Many beautiful colors are now prepared from naphthaline. I have only time to show you one of them—namely, this naphthaline scarlet, which is, I think, quite sufficient to prove that the once despised naphthaline, so detested by gas managers (from the way in which it stops up their pipes), has now an important place among the color-yielding products of coal tar.

Diphenylamine Blue.—My friend M. Charles Girard, by heating aniline with hydrochloride of aniline, succeeded in producing a new alkaloid called diphenylamine. By heating it with oxalic acid it yields a superb blue, which, when treated with sulphuric acid, yields a sulphonate having the character of an alkaline or Nicholson blue. Seen by the aid of burning magnesium, its shade is very beautiful.

Picric Acid.—Among the many constituents of coal tar is a substance called at various times by the names of phenol, phenic acid, and carbolic acid. It is another of the many gifts to science of the German chemist Runge. It is now so valuable as a disinfectant and antiseptic that surgeons and physicians would be at their wit's end without it. As a dressing after surgical operations, especially on the battle-field, it acts like a charm; and inhaled with steam, in even the worst cases of sore throat, its effects are truly wonderful.

But it is not with its medicinal effects that we have to do this evening. When treated with nitric acid it yields a substance to which numerous names have been given at various times. We will simply call it picric acid. It dyes silk a delicate sulphur yellow, which is very permanent. It is a substance which requires to be used with caution, as its salts are very explosive, as you will see when I heat a little picrate of potassium on a spatula. It has been proposed by some artillerists to use it in warfare, but it has been rejected as uncertain and treacherous.

Anthracene.—When coal tar is distilled, and the still is at a very high temperature—too high, indeed, for the mecurial thermometer to register—a substance comes over in a very impure state, called anthracene. It remained a mere scientific curiosity until two celebrated German chemists, Graebe and Liebermann, made the brilliant discovery that anthracene could be converted into alizarine, the principle coloring matter of the madder root. It is this substance with which the famous Turkey red dye (so well known for its fastness and beauty) has been prepared almost time out of mind. I have here a specimen of cotton dyed with alizarine from coal tar.

The alchemists called the worthlesss remedies contained in their alembics a *caput mortuum;* but here we have the *caput mortuum* of a *caput mortuum*—the residue of a residue—and yet at the bidding of science the last residues of the distillation of coal tar, known of old by the name of dead oils, yield the raw material for the production of the brilliant coloring matter of a plant.

So much, gentlemen, for such of the coloring matters of coal tar as I have had time to describe. I have done my best to be brief, but I cannot help feeling some alarm lest I should have wearied you. I will therefore turn for a moment to a question in which you are all, I believe, deeply interested—namely, the effect of the contact of tar upon the illuminating power of coal gas.

The subject has been ably treated by Mr. Bowditch, Mr. Livesey, Mr. Patterson, and others; and I think it has been pretty generally agreed that the contact of tar at ordinary temperatures deteriorates the illuminating power of gas; but I am not aware of any photometric experiments showing the exact amount of deterioration taking place in an apparatus of a given size. My friend Mr. Morton requested me to determine this point, and was kind enough to give me every possible assistance in making the experiments. If they have any value, the credit belongs to him, but for any defects or want of completeness, I take the entire responsibility. I may, however, say that the investigation is still proceeding.

In order to make the results strictly comparable, an experimental gas-holder was filled before each series of observations. To effect contact of the gas with the tar, an apparatus 7 feet in height and 9 inches in diameter was used. The tower was filled with clinkers saturated with tar, and the gas was passed through at the rate of 5 feet per hour. The tower was surrounded with a jacket, into which steam could be passed to increase the temperature; but it was not used in the experiments I am about to describe. The temperature of the gas was estimated by an accurate thermometer placed at the exit from the column. The lowest temperature recorded was 50°, the highest 60° Fahr.

Before reaching the photometer the gas passed through a purifier containing oxide of iron, to intercept any sulphuretted hydrogen with which it might have become contaminated during its contact with the tar. At the upper part of the column a syphon was placed to enable the tar to be poured into the column without permitting the entrance of air. At the lower part of the column an exit-tube was placed to allow of the escape of the excess of tar. This tube was sealed by dipping it into tar covered with water. Precautions were, of course, taken that every trace of air was expelled before the gas was tested.

In the first series of experiments the gas, before being passed over the tar, gave, as a mean of 50 closely-agreeing experiments, an illuminating power of 16.24 candles. After passing over the tar at the same rate, the gas gave, as a mean of 100 photometric observations, an illuminating power of 14.39 candles. This indicates a loss equal to 1.85 candles.

In a second series of trials a fresh sample of gas, before contact with the tar, gave an illuminating power equal to 15.19 candles, and after contact with the tar 13.01 candles; the loss being equal to 2.18 candles.

As the difference between the first and second series of experiments is only 0.3 of a candle, it may with perfect safety be said that, under the circumstances indicated, the gas is injured to the extent of two candles. The photometric observations were made with Mr. Methven's standard light, which I found admirably suited for experiments of this kind.

Allow me to return to the coal tar colors for a moment, as I wish to remove an absurd impression which prevails among some persons that all aniline dyes are poisonous, and contain arsenic. It is true that magenta, as prepared by Medlock's process, contains traces of arsenic, but certainly not enough to do the slightest harm to any one wearing any article dyed with the color. All the other dyes are perfectly free from arsenic, and

Mr. Anthony Nesbit has fed rabbits for weeks together upon food containing most of the dyes I have mentioned to-night, and, strange to say, if one may judge from their appetite and condition, their general health was not in the least impaired. It is true that some pigments—that is, paints, not dyes—like orpiment and emerald green, contain large quantities of arsenic. Orpiment should never be used, as it gradually fades, and the deplorable way in which Sir Joshua Reynolds's pictures have deteriorated is partly due to the use of orpiment and carmine; this last color, although perfectly harmless, becoming grey in the course of time.

Future of Coal Tar.—Permit me, in conclusion, to say a few words on the Future of Coal Tar. It may confidently be said that none of the products of coal tar are useless. A well-known chemist, several years ago, in a work which in many respects showed great cleverness, was unwise enough to reproach chemists for the enormous labor which they had bestowed on what he called so useless a substance as aniline. He, however, lived to see it become one of the most valuable substances in existence. It is true that the leucoline and pyridine series have not as yet been utilized; but to doubt that they would one day yield valuable derivatives would be to neglect all the teachings of our glorious science. Nothing exists in vain, and the chemists who, for the sake of pure science, study the physical and chemical properties of new and as yet useless substances are preparing the way for the practical man, who will one day be thankful for those pioneers who have smoothed the road, and made the advance into new realms comparatively easy. Although the leucoline series have not yet been utilized, I found a quarter of a century ago that its isomer, chinoline, by alternate treatment with iodide of methyl and oxide or sulphate of silver, yielded superb colored reactions, and doubtless, by suitable processes, the leucoline series will be made to afford valuable products.

I found also that chinoline, treated with iodide of amyl, and then with caustic alkalies, yielded the superb blue coloring matter cyanine. This color, from its peculiar constitution, forms quite a new departure in organic chemistry, and recent researches show it to be closely allied to our subject; as, from the observations of Ballo and Dewar, there seems to be little doubt that chinoline at times, and perhaps often, accompanies or replaces leucoline in coal tar.

There are also many other substances which have not yet been utilized, among which I may mention the solid hydrocarbons chrysene, retene, and pyrene. It needs no prophetic eye to see that, with the substances already known, there is room for an absolutely endless number of new combinations, and the Future of Coal Tar will be far more brilliant than the Past or the Present.

To me, gentlemen, coal tar, though "black," is "comely," and if I have failed to impart to you some of my enthusiasm for it, the fault lies with me, and not with the subject, which I feel is worthy of treatment by a master-hand.

[From the "London Journal of Gas Lighting."]

Experiments on the Thermal Power of Gas Heating Apparatus.

By Mr. T. Travers, of Cork.

Read at meeting of British Association of Gas Managers, June 8, 1880.

In a paper which I had the privilege of reading before you two years since, your attention was called to the fact that gas cooking and heating stoves did not, as a rule, give the full thermal effect practically available from them. To us this is a matter of importance, as one of the points with which we have to contend is to demonstrate the economy of gaseous fuel. At present this can only be done when gas is consumed under the most favorable circumstances.

Manufacturers of gas cooking and heating apparatus are succeeding very well in making them attractive to the eye. Both in style and finish they are suitable to grace, in many instances, a well furnished room; but to render them more popular, attention must be paid to the mode of developing the largest amount of heat from the smallest quantity of gas. What I purpose showing is that in the majority of instances this is not obtained, and it is that additional pressure be put on the stove makers, so as to enable us to speak with more confidence to our consumers.

As a kindred case in point, you are aware that some years ago gas burners then in use did not give the same amount of light per foot of gas as we now obtain. If the electric light did no other good than to arouse the burner makers to the sense of injustice they were so long perpetrating on gas makers and gas consumers, by impeding the full development of the illuminating power, it has done good work. In like manner let us spur on the stove manufacturers to that which will certainly prove to be of mutual benefit.

In order to be able to recommend to the gas consumers of Cork the best and most economical apparatus, I made, during last year, some experiments, and from the results of them I think it will be seen that the apparatus in general use are capapble of such improvements as will lead to better results. I am fully aware that the effect of any kind of fuel is much greater in theory than in practice. I have therefore made the experiments on a plain, practical method, such as may be applied to the doings of every-day life.

Intimately connected with this subject is that of the thermal power of gas of various qualities, and I commenced operations by making some tests under this head. I noticed that the results are not quite in accordance with some I have seen in the journals. The apparatus with which I operated was capable of carbonizing 30 cwt. of coal per day. I was therefore able to make a comparative calculation of the cost of the gas from coal of various qualities. The coal was Scoth cannel, Newcastle coal, and coal from South Wales. The points noted were—

The illuminating power.
The evaporating power of the gas.
The net cost of coal per 1000 cubic feet.

Coal.	Illuminating Power.	Water Evaporated.	Gas Consumed.
Cannel	24.0 candles.	1 gallon.	18.50 cubic feet.
"	22.0 "	1 "	19.75 "
"	20.0 "	1 "	20.50 "
Newcastle	16.5 "	1 "	21.75 "
"	14.5 "	1 "	22.00 "
"	13.5 "	1 "	22.50 "
South Wales	10.5 "	1 "	28.00 "
South Wales and 20 per cent. cannel	14.0 "	1 "	23.50 "

Of course the thermal theoretical efficiency of the various descriptions of gas is far greater than the results which are given above.

On the average it will be found by the experiments that 16 lbs. of water were evaporated by 1 lb. of gas. Newcastle coal gas, for example, of sp. gr. .420 has an evaporating value equal to 22 times its weight. From the figures it will also be seen that the thermal power does not increase in the same ratio as the illuminating power, as some persons suppose. The calculations I have made of the net cost of coal per 1000 feet of gas prove that a very cheap gas of low illuminating power can be produced for heating purposes, provided we were able permanently to enrich it at the consumers' meters when used for illuminating purposes—an experiment worthy of the attention of the inventive portion of the community.

Taking gas from Newcastle coal at 16 candles as a standard of the average gas at present supplied, and 750 as the thermal units per foot of gas, I made a series of experiments on the gas stoves from the various makers. I took the stoves as they are delivered in the usual way to purchasers.

	Thermal Units per Cubic Foot of Gas.
No. 1.—Cooking stove fitted with a Bunsen burner formed by a ring of 1¼-inch wrought iron pipe with jet holes 1 inch apart gave	244
No. 2.—Boiling stove, consisting of single burner 9 inches diameter, made of ¾-inch pipe, jets ¼ inch apart	260
No. 3.—Hot-plate, consisting of three rings, each 6 inches diameter, jets ½ inch apart	280
No. 4.—Like the above, rings 4 inches diameter	310
No. 5.—Cooker, formed of bars of 1-inch wrought iron pipe, jets ½ inch apart	338
No. 6.—Concentric burner, consisting of a double row of rings, one inside the other, 6 inches diameter	390
No. 7.—Burner, same construction as above, but 4 inches diameter	408
No. 8.—Solid flame burner	450
No. 9.—Wallace's burner adapted for domestic purposes	580

To the construction of this burner is due the higher return of work than from the others. It is on the principle that jets of fluid escaping from an orifice travel on in their original direction of motion a certain distance before they disperse. In this burner the gas is made to leap across a space, and in doing so it communicates a sort of gaseous friction to the air. Both then move in the same direction, but with a retarded motion; thus they become mixed in a chamber, from which they escape through a wire gauze, and they burn at a point of exit in the shape of solid flame, varying in diameter according to the size of the burner. Here we have a very powerful concentrated heat, developing a very large percentage of the calorific efficiency of the gas.

It is important to ascertain the reason of this. You are aware that in combustion for the purpose of artificial light, we have a very interesting arrangement of nature. The combination of oxygen with hydrogen causes powerful heat, and consequent expansion. Hence the particles of carbon are scattered freely through the heated hydrogen, and thus they remain for some time before their exit; and from their incandesence, diffused in all directions, we obtain beautiful light. But in the Bunsen burner the case is different. The oxygen is introduced in such quantities that there is not

time to allow the carbon to radiate its light. It is at once converted into convected heat—that is, the transfer of heated air from one place to another, moving in one direction—and thereby we obtain from this lightless flame intense heat. But note the difference—not hotter, nor nearly so hot, to a body exposed to its radiation, but very much hotter to a body plunged in the flame. It is by attention to this principal of convected that, for certain purposes we obtain the best results from the Bunsen burner, while for other purposes radiated heat is more suitable.

Professor Tyndall very clearly illustrates the difference between the two. With ordinary gas burners the convected heat generated is 80 per cent.; radiant heat, 16 per cent. In the Bunsen burner 96 per cent. is convected heat, and 4 per cent. radiant. Tyndall has found that radiation from a luminous gas flame was 2½ times that from a non-luminous flame. Using an apparatus of an exceedingly sensitive precision, furnished with a dial index that noted the degrees of force, not of heat, the degree of force in a luminous flame was 30, and the radiation fell to a force of 12 the moment it became non-luminous. But by introducing solid matter the radiation originating in the hydrogen or non-luminous flame became so intense that a spiral of patinum wire plunged in the former brought up the index to 200. There was thereby generated an amount of radiant heat more than six times that of the luminous gas flame, and more than thirty times that of the non-luminous one.

A few months since I had a practical illustration of the advantage for certain work of a luminous over a non-luminous flame, and one which will be found to apply in many similar cases. In a low-lying district we erected a stove from one of the best makers, but the day pressure was not sufficient, and the result was that the Bunsen burner, which formed the heating ring in the stove, frequently fired back, and was thereby a source of annoyance, and so retarded the efficiency of the range that the consumer became dissatisfied. To increase the pressure was out of the question. To meet the case if possible, I converted the non-luminous into a luminous flame, and since then we have had no firing back. The consumer is perfectly satisfied, both with the quality of the cooking and the convenience of the stove; and the consumption of gas is not increased by the alteration, for much of the heat that was before lost by convection is now converted into radiant heat. Bunsen burners, to be used for heat-giving in fire-places are, to my mind, and for the reasons given above, a mistake; for, unless special arrangements are made, over ninety per cent. passes off in the shape of convected heat.

I think it is clear that there is here a wide field for the exercise of skill and ingenuity for such as are interested in this portion of our business. There is a practice very strongly to be condemned—viz., the course pursued by some who attempt to fix heating stoves without making provision to carry off the products of combustion; and makers who recommend such ought to be made aware that they are thus displaying an ignorance of a very elementary portion of their business.

I am glad to find, in a paper read by Mr. Fletcher, of Warrington, before the Society of Arts a short time since, that he corroborates the experiments referred to in this paper. This is an illustration of the fact that two persons very often arrive at like results when pursuing the subject quite independently of each other.

Discussion.

Mr. F. W. Hartley (London) said he was somewhat surprised at the low calorific effect obtained by Mr. Travers with a ring burner—only 244 units. Mr. Travers was somewhat hard on makers of stoves who, to a great extent, were forced to make cheap things to suit the public, who, as a rule, were indisposed to pay the prices required for good ones, and, indeed, in many cases, were incapable of using the best. He (Mr. Hartley) had for years been interested in the subject of the use of gas for heating purposes, and could say that the calorific power of London gas had not sensibly changed during the past seven years—indeed, he was sure it had not changed during a much longer time, but said seven years, as his records prove this. About Christmas last he was led, owing to interest re-excited in his mind by being engaged as a juror, both at the Birmingham and Nottingham gas apparatus exhibitions, to repeat old experiments and make some, to him, new ones. He first sought to ascertain, as nearly as possible, in a practical way, the total calorific power of ordinary coal gas, and having at Nottingham realized, with a very excellent water heater, 626 units, he borrowed a similar one from the maker, and from London gas realized in the water 612 thermal units. In addition, he noted the temperature of the casing of the heater and of the air, as well as of surrounding objects. Besides noting the temperature of the effluent gases, he also took means to ascertain their volume. When all these factors were taken into account, the calorific power of the gas was shown as 680. Mr. F. J. Evans a few years ago determined the power as 650 units, while Mr. Harcourt and some others fixed upon 700, which he believed to be very near the truth. The calorific power might be calculated from the composition of the gas, but the question arose, what was its composition? One authority some time since gave such a composition as indicated London gas to be of .396 specific gravety, and its calorific power to be 695, while another more recently gave such a composition as indicated a specific gravity of nearly or quite .500 (for common gas, be it understood), and a calorific power of 797. Both of the calculations were subject to a small deduction for the effect of the presence of small percentages of carbonic acid, nitrogen, and oxygen in the gas. The gravity of the gas, as worked out from the last analysis, seemed to indicate that the analysis was wrong. He had found London gas as high as specific gravity .430; but, as far as he had ascertained it, it was generally somewhat lower. If it were not now, unfortunately a very common practice for vendors generally to put exaggerated statements before the public as to the merits and powers of the article to be sold—a practice for which vendors were not altogether to be blamed—he (Mr. Hartley) should be astonished at the audacity, arising, he thought, as much from want of knowledge as anything else, with which some makers gravely stated that their particular specialty developed from 50 to 100 per cent. more heat from coal gas than science showed to be possible. He must confess, however, that he was surprised that a gentleman of high skill and experience in the application of gas for heating purposes should make such a blunder as to state and to believe that he had "got in actual work 1 gallon of water boiled with an expenditure of 1½ cubic feet of gas." He said "blunder," for either the the calorific value of gases, as determined by scientific men of the highest standing, and given in the best text-books, were fallacious, or Mr. Fletcher, of Warrington, must be wrong. The Manchester gas was richer than London gas, but he (Mr. Hartley) ventured to say with some confidence, it was far from being so much as 100 calorific units greater in power. Assuming for the sake of demonstration, that Manchester gas was of 800 units power, and what followed? One gallon, or 10 lbs. of water, raised through 152° (from 60° to 212°F.) required 1520 units of heat, and if 1½ cubic feet only of gas sufficed, the calorific power of the gas would be equal to 1013 units per cubic foot, or at least 27 per cent. in excess of possibility. He believed Mr. Fletcher's statement to be in error to a much greater extent, for the water was said to have been boiled. Now as higher temperatures were reached with water, more heat went as it were to waste, the highest calorific power being manifested in ordinary heating when the water was kept under about 100°F., and raised only through about 40° or 50°F., because the water of combustion escaped as steam along with the generated gases at higher temperature, and this higher temperature operated to produce a more rapid draught of air over the vessel that contained the water which was being heated.

The following, he said, represented a fair average of the results which he had obtained, and showed the values of the gas per cubic foot in raising water from 60° to 210°F., in a tin kettle placed over a good air burner; the air and walls of the room being at 60°F.:

Water raised	18°F.;	calorific	power	of gas per cubic foot.....	450
"	44° "	"	"	"	440
"	83° "	"	"	"	412
"	121° "	"	"	"	403
"	150° "	"	"	"	394

Hence the average power was only 87.55 per cent. of that first indicated, and such must always be the case. Sometimes in cold weather he had only realized from 74 to as low as 61 per cent. He thought it was hopeless to expect to realize in heating water more than 90 per cent. of the actual calorific power of any gas, however much apparatus might be improved. Now, 90 per cent. of 800 was 720, which divided by 152 (the difference between 60° and 212°F.) gave 4.73 lbs. as the possible weight of water which might, by an extremely refined mode, be raised from 60°F. to boiling point; this was equal to 7.09 lbs. instead of 10 lbs. for 1½ cubic feet of gas. Still, taking 90 per cent. as a practically possible maximum, and 700 as the power in units of common gas, there were 630 units, which were capable of raising 4.145 lbs. of water from 60° to 212°F. At the present time, by the agency of the best kettles and burners in use, not more than about 2.66 lbs. of water were so raised in temperature. Most baths which were directly heated by burners below them rendered less than 400 units to the foot of gas burned, though he had found some in which the heat developed in the water had risen as high as 470 units; but, unfortunately, the economy had been accomplished at an enormous sacrifice of time. One bath, which was specially referred to, required about an hour and a quarter to raise 30 gallons of water from 60° to 100° F.: while others, burning gas less effectively from a scientific point of view, so-called, did the same work in from 30 to 40 minutes.

Water heaters, so-called, also gave the highest calorific results when the water was raised to only about 100°F., and through from 40° to about 60°F. The heater which he had mentioned as yielding up to the flowing water 612 units per cubic foot of gas, was used under such favorable conditions as had been mentioned, the outflowing water being 102°F.; but when with the

same heater the water was raised to 182° F. from 38°F., the realized heat fell to 471 units. Again, when it was tried with the gas consumption very low, and the water raised through only 11°F., the indicated heat heating power was 388 units, or about the same as was realized with an ordinary kettle. Truly these tests were very severe, but he mentioned them to show that it was only under certain conditions that the things called water heaters were greatly superior to other heating apparatus. In his paper on "Cooking by Gas," which was read before the Association at the meeting in 1873, he said that, in his opinion, ovens of circulation, if he might call them so, were to be preferred to those which cooked by the heat of radiation. He was still of the same opinion; but in his investigations he had been struck with the beauty of many of the radiating stoves which were now being made and with the admirable manner in which they did their work. It was not his intention to say one word in their disparagement, for they overbore a stupid prejudice which some of the public had against subjecting food, in the older types of cooker, to the products of combustion; but what he did regret was to see that so many makers should use air burners for radiating heat, in ignorance, it would seem, of the fact that the amount of heat radiated by the non-lumiuous flame of mixed gas and air was greatly less than that from a luminous flame burning the same quantity of gas. It must be admitted, however, that in cookers the difference was far less than when the burners were in the open, and for the reason that the burner was surmounted by a deflector, which became hot and radiated downwards part of the heat which it received from the burner beneath it: but this benefit was too often dearly purchased, for if the deflector were near enough to the burner to produce the best effect, then if the gas were turned the least degree too high, imperfect combustion ensued, with the evolution of an odor offensive to the nose, and of fumes highly irritating to the respiratory organs. In the course of the experiments which he made he used several small heat-radiating cookers. Some which he bought were fitted with air burners, and one with a circular jet burner. For the last he had an air burner made, and for the others jet burners, so that he could substitute in such a cooker either sort of burner for its opposite. Next he had some vessels of tin plate made, which closely fitted the ovens, and were each about an inch deep. These were protected at the bottom and front by a casing of wood, to prevent as much as possible any cooling effect from the air. They were also fitted with tubes, which served for the insertion of a registering thermometer, and also afforded room for the expansion of the measured quantity of water with which each vessel on every occasion was filled. These vessels were placed at the same distance below the burners in all cases, and at a little less distance than the cooking pan was intended to be. To complete the information he used the vessels both with bright tinned surfaces and with the same surfaces blackened by the best of all blacks—namely that deposited by gas burned smokily. The differences in heat absorption between bright surfaces and blackened surfaces ranged with the air burners in the proportion of 100 with the bright surface to 250 with the blackened surface, and with the luminous jet burner in the proportion of 100 to 246; while the proportion of heat obsorbed by the bright surface heated by the air burner, as compared with the same heated by the jet burner, was 100 to 131; the ratio with the blackened surface being 100 to 128. Taking the calorific value of the gas at 680, as determined by himself, the average of a number of experiments with blackened vessels gave 7.83 with the air burner, and 9.95 with the jet burner as the percentages of heat realized in the radiant form. These quantities were almost incredibly small. However, Mr. Fryer and he agreed at Nottingham that it would be well to try certain reflector stoves, and that gentleman made a vessel of tin plate, blackened on its face, measuring one foot square, cased in wood, and of a capacity to contain exactly one gallon of water. This was placed vertically at a distance of six inches from the stoves which were tried. Taking Nottingham gas as capable of yielding 700 thermal units, the results he obtained worked out at 9.3 and 9.64 per cent. only.

This by no means represented the effective heat power obtained in use. For in heating water by convection, as an old experiment showed, the top surface might be boiling while the lower part was cold, but the experiment served to show the relation between the kinds of burners. All such experiments gave correctly enough the ratio between certain burners or apparatus but by no means indicated their effective value in actual work, such value being greatly higher. The reason for the low indications was quite easy to understand, but it was difficult to devise means whereby to realize working effects. Reverting for a moment to cooking stoves—ovens of convection—he might say that he had sought to find some factor which should be a standard of economy. It was known that in most things with which gaseous or other fuel was used, the proportionate expenditure of fuel diminished as the power for work of the things increased. So it was with gas ovens; the larger they were the less gas per cubic foot of capacity did they need, if properly constructed.

He had observed that the ratio of consumption tended to be proportionate inversely to the cube root of the capacity, and he had little doubt that if all the stoves he tested had differed in no other respect than in size, such rule would be found very near the truth. Thus—

Cubic Capacity of Oven. Feet.	Gas burned per Hour per cubic feet of capacity.	Gas needed, as calculated by assumed Rule.
19.00	3.56	—
12.00	4.00	4.13
18.00	4.65	4.73
1.66	9.70	8.08

If some such standard could be established for each particular class of stove it would facilitate the estimation of relative worth, and possibly save some things, which merited approval, from condemnation.

Mr. A. G. Vernon Harcourt said he hardly knew whether it fell sufficiently within the scope of the paper which had been read, but, seeing the title on the list, he thought he would like to describe a small apparatus for the application of the heating power of gas, which was often wanted, and which ought to be wanted more frequently—namely, the heating of a small conservatory during the winter, in order to keep out the frost. This was a very common need amongst householders in this country, and he was consulted by a friend of his as to how he could most conveniently manage it. He thought it could be most advantageously done with gas, because there would be less trouble; and, after thinking about it, he contrived a simple and small apparatus, which had stood the test successfully of the two last winters, which had been longer and more severe than English winters commonly were. The arrangement consisted of a little cupboard hollowed out lower than the level of the floor of the conservatory to be heated, in which a Bunsen burner was placed. This opened through a grating into the conservatory, so that any radiated heat was not lost, and immediately above the burner was placed an ordinary rain water pipe, which was carried round the conservatory, and then out through the wall to a chimney, so that the whole of the heat produced by the gas, and the heat radiated from the tube passed up through the grating into the conservatory, and was not lost. The products of combustion—carbonic acid, steam, nitrogen—along with the excess of air which entered the tube, passed altogether round the conservatory, and out through the wall to a chimney carried a certain distance above the roof. The difference of temperature between the heated gas in the first portion of the tube, and the slight difference that still existed between the gas in the chimney and the outer air, was sufficient to secure a movement of the products of combustion throughout the pipe, and the burner drew very well, even on windy days. What he aimed at accomplishing was this—that as nearly as possible all the heat produced in the combustion of the gas should be utilized in the heating of the room. All one needed to secure was that the whole of the heat produced where the gas was burning, and all the heat that went off in the process of combustion, except the very small quantity necessary to secure a draught, should be utilized. The pipe was very hot at first, but gradually, as in an ordinary air condenser, the temperature sank as the heat was given out in passing through the iron pipe, and the gaseous product as it issued from the chimney was scarcely warm to the hand. Therefore, but a very small quantity of heat was lost. Whatever the absolute number of units produced by the combustion of gas, what one wanted to be sure of was that the least possible amount of heat should escape; and when this had been done, all that was posssble had been accomplished. The arrangement he had described was very simple. It was effective and not costly. The labor was simply *nil*, since it was only necessary to turn on the tap when one wanted to light the burner, and turn it off when not wanted, whilst more or less gas could be burned, according as the temperature required was higher or lower.

Mr. A. H. Wood (Hastings) said that for ten years past he had warmed a greenhouse in a similar manner, and for eight or nine years he had a striking-pit in which there was a coil of 2-inch pipe laid horizontally in the bottom of the pit, with 9 or 10 inches of earth above, and under it a jet burning about one cubic foot of gas per hour. Nothing but the products of combustion were carried off by a pipe at the end, and this last spring he had taken out several pans of cuttings, every one of which had developed into a very nice plant.

The President said Mr. Harcourt had described a most simple and excellent method of heating greenhouses, such as was very much wanted. There was a wide field for the employmont of gas in this direction, and he would only ask him whether he considered the upright pipe absolutely necessary, or whether it would not be sufficient to stop short without taking the pipe through the wall, trusting to the heat of the gas to produce the necessary draught?

Mr. Harcourt said it depended upon how far below the level of the conservatory it was possible to get. He had constructed more than one of these arrangements, and in his own house, where he could get down some 12 feet below the floor of the greenhouse without burrowing, and so had a longer pipe above the burner, he did not use the chimney, but simply allowed the products of combustion to issue at the level of the horizontal pipe,

In the other case, where he had only a rise of something like four feet, he found he had hardly power enough, and therefore had to put on the extra chimney. He had omitted to point out that there was an arrangement at the lowest part of the iron pipe for letting the condensed and rather acid water produced in the combustion of the gas run out. It was necessary that this should be done, or else it would lie in the pipe, and cause corrosion.

Mr. Travers, in reply, said he was glad to find that his paper had led to such important conclusions as had been made by Mr. Hartley and Mr. Harcourt. Mr. Hartley seemed to doubt the fact of his having obtained only 240 units of heat from a ring burner; but such was the fact, for he had repeated the experiment several times. His object was simply to point out how much below the mark some of the stoves were, and hence the reason why there were so many complaints as to the excessive cost of gas when used for heating purposes. He heartily agreed with Mr. Hartley in his remarks with respect to the efficiency of gas stoves.

Mr. Hartley said it was quite a mistake to suppose he had doubted Mr. Travers's statement; he had only expressed his surprise at the result.

[From the London "Builder."]

The Effect of Sulphates on Lime Mortar.*

In the year 1870 the author commenced to experiment on the subject of the effect of sulphates on lime mortar, and finding himself at the beginning of 1879 unable to further pursue his investigations, he decided to submit a paper on the subject to the Institution of Civil Engineers, with a view of enabling others to give the matter their consideration. It afforded him pleasure to find that that body appeared to appreciate his labors, inasmuch as it accepted the paper and set it up in type. However, as twelve months had elapsed and there was no appearance of the paper being read this session, the author determined to withdraw it, and by the kind courtesy of the Council of this Association he is enabled to bring it before the present meeting.

It was observed by Major, now Major-General, H. Y. D. Scott, C.B., Assoc. Inst. C.E., about twenty-five years ago, that the chemical combination of a small quantity of sulphurous acid gas with limes had the effect of causing them to set, after the manner of cements, without increase in bulk or any considerable elevation of temperature. The union of the gas with the lime was first effected by allowing sulphur fumes to pass into the kilns during the process of calcination; but more regular results have since been obtained by mixing either a soluble sulphate or sulphuric acid with the lime before being burnt. In ordinary mortar the lime, before being mixed with the sand, is brought to a state of fine division by slaking with water, that is chemically; whereas in General Scott's method mechanical appliances are resorted to in order to reduce the lime to powder, and water containing finely ground plaster of Paris, or other soluble or partially soluble sulphate is then added. When these have been reduced to a creamy paste, the sand is put in, along with any further quantity of water necessary to render the mortar when mixed convenient and fit for use. Mortar thus prepared may be used even for plastering purposes shortly after being mixed, as the lime when treated in this manner shows no tendency to slake. The quantity of sulphate required to be added varies with the description of lime, and is much governed by the proportion of clay which it contains. Those limes in which only traces of alumina are found, such as the pure chalk limes, require about 7 per cent., whilst blue lias and other hydraulic limes require but 3 or 4 per cent., and with very clayey limes the amount of sulphate may be reduced to 2 per cent. of the bulk of the lime. The principle of General Scott's invention, now generally known as the selenitic process, is so to combine the lime with water that it shall not burst with the heat, and, in fact, to arrest the slaking of the lime so that the setting may take place without increase to its volume. By this means the strength of the mortar is increased, and it is rendered quick-setting, which is a very desirable property under many circumstances.

In ordinary building operations, however, the mortar must not be too quick, or it may set before it can be got into the work. A strong, but comparatively slow-setting mortar is often, therefore to be preferred. The experimental results contained in this paper lead the author to believe that such can be procured by first thoroughly slaking the lime with water, then adding the sulphate to it in that state, and afterward the sand, ashes, puzzuolanas, or other ingredients, and mixing the whole in the usual manner. If this method be pursued, and four of five parts of sand be added to one part of slaked lime, a slow-setting mortar will be produced, possessing after having set for some time much greater strength than selenitic or Portland cement mortars containing a similarly large proportion of sand. The characteristics of this mortar are therefore entirely different from those of the latter compositions. It would appear that General Scott entirely directed his attention to the neutralization of the slaking properties of quick lime, and not to the employment of a sulphate with slaked lime, as here proposed, in mixing ordinary mortar.

The adding of plaster of Paris to lime has frequently been said not to be a new process, inasmuch as it has been used by builders for an indefinite period both with and without lime for plastering purposes, in order to produce a fine quick-setting mortar. The proportion of plaster employed for this purpose, however, has always been much larger than that adopted by General Scott, and proposed to be used by the author. The builder has hitherto mixed a large proportion of plaster with lime on account of its quick setting properties as a material, and employed the resulting composition for rendering the interior of rooms and similar descriptions of work not exposed to wet or damp; and in such positions, were it not for the question of cost, many would prefer neat plaster of Paris. This mortar prepared with plaster of Paris, if subjected to wet or damp, would crack or disintegrate, whereas that which the author advocates is suitable for all situations in which it is customary to employ an ordinary mortar. The plaster of Paris, that is, sulphate of lime, is added in small quantities, because it is the most convenient and economical medium for supplying the requisite chemical constituents. The builder would deem plaster which has been once set as worthless; however, it may be inferred that, if this substance were re-ground, it would answer in the processes which are now being considered nearly as well as fresh plaster of Paris.

In 1870 the author, then having charge of the testing of the various cements and mortars employed in the works in progress at the Liverpool Docks, availed himself of the facilities thus placed at his disposal, to test the effect of mixing sulphates with the slaked lime. The results being somewhat extraordinary, it has been thought advisable to bring them in detail before the Institution. The lime used in the experiments, unless otherwise pointed out, was Halkin lime, from Flintshire, in North Wales. The limestone from which this lime is derived contains about the same amount of silica and alumina as that from Barrow, and produces an hydraulic lime, which, however, is not equal to Warwickshire blue lias lime in setting or hydraulic properties. The proportions given in the accompanying tables are in all cases by volume; and where the quantity of any ingredient is represented by a fraction, such is of one part and not of the whole quantity of mortar. The quantity of plaster of Paris in all experiments with Halkin lime was a percentage of the quantity of slaked lime. The various descriptions of mortar tested were mixed in mills on the site of works in progress, and by men daily employed in such duties; and every endeavor was made to insure that the experiments should be carried out under as nearly as possible similar conditions in each instance.

The first series of experiments was with briquettes having a sectional area of 2½ square inches, such as usually made for testing Portland cement. These were drawn asunder by means of a Michele lever cement-testing machine. [The results and all particulars were given in tables.] It remained to be seen how the addition of plaster of Paris would affect mortar intended to be set under water. Experiments tended to prove that the ultimate strength of the ordinary Halkin mortar was not impaired by immersion in water, but that the strength of the mortar containing a small percentage of plaster was materially reduced. It would appear from these experiments that by adding plaster of Paris to slaked lime the strength of the mortar will be increased and the cost reduced, consequent on the larger proportion of sand which may be employed; and it may be inferred that experience will demonstrate the advisability of employing plaster of Paris in mortar to be used in ordinary building operations, but that it would not be advisable to add it to slaked-lime mortars intended for hydraulic purposes.

The author does not wish it understood that he considers any description of lime-mortar can equal in strength or setting properties neat Portland cement or Portland cement mortar, in which a small proportion of sand is used. However, when a large admixture of sand is made, slaked-lime mortar prepared with plaster appears to be decidedly stronger than Portland-cement mortar containing a similarly large proportion of sand. Even ordinary Halkin-lime mortar, when mixed in the proportions of 2½ to 1, at the age of six months, is about equal in strength to Portland-cement mortar mixed in the proportions of 4 to 1.

It may, on the whole, be taken for granted that mortar composed of four or five parts of sand to one part of slaked lime can be made possessing greater strength than Portland cement mortar mixed in similar proportions. The economy to be effected is evident when it is considered that the normal price of Portland cement is not less than 2s. per bushel, whilst a bushel of slaked lime does not cost one-third that amount.

The broken portions of the briquettes with which the first series of experiments was made have been exposed to the weather since 1871; those mixed in the proportions of five parts of sand to one part of slaked lime give evidence of being sound material, and of having stood equally well as those mixed without plaster in the proportions of one to two and one-third.

* From a paper by Mr. Graham Smith, C.E., read at the annual meeting of the Association of Municipal and Sanitary Engineers and Surveyors, held at Leeds, on May 27th, 28th, and 29th.

In making mortar the proportions of sand, ashes, and other ingredients which ought to be adopted, depend entirely upon the nature of the lime; for instance, no engineer would put as much sand with blue lias as with grey-stone lime. In the process now proposed similar laws will hold good, but, as a rule, double the quantity of sand may be used when plaster is added, that would be considered proper with any particular lime under ordinary circumstances.

In conclusion, it may be stated that neerly 800 experiments with bricks and briquettes, carried out in various manners, tend to indorse the general results accompanying this communication and the opinions advanced, which are briefly:

That the ultimate strength of all lime mortars will be much increased by the addition of a small percentage of plaster of Paris, and that, when mixed in the manner described, they will apparently at first possess similar properties to ordinary mortar made with the same kind of lime in the manner as at present practised.

Slag Cement.

We have on several occasions directed attention in this Journal to the very important question of the satisfactory utilization of the slag produced from blast furnaces. In past years this product has been accumulating to a vast extent, and the iron masters have been put to enormous expense and inconvenience in providing places of deposit for many millions of tons of this, until very recent date, comparatively useless article. It is true that in some few instances it has been employed in filling up shallow bays, and even for making roads in the immediate vicinity of the works where it is produced, and where other more suitable material cannot be conveniently supplied, but for both these purposes the demand has been extremely limited, and in the vast majority of cases it has been got rid of as so much rubbish.

One very important use to which blast furnace slag has been proposed to be put has been in the production of bricks for building purposes, and for this application Mr. Charles Wood, the manager of the Tees Iron Works, Middlesborough, obtained a patent in the year 1873, and full description of the processes employed by Mr. Wood have appeared in our columns. More recently we had occasion to speak of a patent obtained by Mr. Frederick Ransome (who for nearly forty years past has been prominently before the scientific world as the inventor of several valuable and ingenious processes for the manufacture of artificial stone) for the production of an eminently hydraulic cement, in which the slag sand from the blast furnaces forms a conspicuous and very important feature, and of this cement we have now something more to say. Good Portland cement, which now enters so largely into the construction of all hydraulic and substantial building operations, is, as our readers are aware, a compound of silicate of lime and alumina, and contains about—

	Per cent.
Lime	62
Silica	22
Alumina	8
Oxide iron	3
Potash, soda, magnesia, etc	5
	100

This composition is generally obtained by intimately mixing chalk and clay, this mixture being burnt at a very high temperature into an extremely hard clinker, which is subsequently ground to a fine powder. Mr. Ransome having been applied to, to produce a cement possessing the strength and valuable hydraulic properties of Portland cement, was not slow to appreciate, and avail himself of the valuable results obtainable by a combination of the slag sand from the blast furnaces with an additional quantity of lime. He at once commenced a series of experiments, and, as we stated in this Journal in December, 1879, he succeeded in producing a cement of a most delicate color, possessing extraordinary hydraulic powers, and acquiring strength, increasing with age. Thus at three days it was stronger than Portland cement at seven days; in seven days it was stronger than Portland cement at three months; at fifteen days it was stronger than Portland cement at twelve months; and at twenty-eight days it was stronger than Portland cement at seven years. The foregoing results were obtained by mixing the slag sand, supplied by the Tees Iron Company, with the white chalk of Essex, in the proportion of about one ton of slag sand to 1¾ tons of chalk, and subsequently burning the same in an ordinary cement kiln. The composition of the slag sand above alluded to was, as stated in our former notice, found by analysis to be—

Silica	38.25
Alumina	22.19
Lime	31.56
Magnesia	4.14
Calcic sulphide	2.95
Protoxide iron, etc	.91

M. Ransome has, however, ascertained that he is able to obtain a still stronger cement by the employment of slags containing a higher percentage of alumina. It was long since discovered and reported by M. E. Frémy and MM. Rivot and Chatony in their admirable works on cements, "That aluminate of lime is the principal hydraulic agent in cements." M. E. Frémy attributes the setting of a hydraulic cement to two chemical actions:

1. To the hydration of aluminates of lime, and
2. To the action of hydrate of lime upon the silicate of lime and the silicate of alumina and lime which exists in all cements, and in this case act as puzzolanas.

The results arrived at by Mr. Ransome fully corroborate these views, and by attaching full importance to the presence of alumina, Mr. Ransome has, as we have mentioned, succeeded in greatly increasing the strength of the new cement. Samples which we have seen show remarkable closeness and hardness, and the material in fact promises to be an exceedingly valuable one. By the employment of blast furnace slag sand the great proportion of the expense involved in the production of clinkers used in the ordinary process of manufacturing cement is avoided; the cost of fuel and expense of grinding being hence reduced, while a useful application is found for what has been until recently a waste product. The Ransome cement, as made from the blast furnace slag sand without the admixture of any coloring matter, is of an exceedingly pleasant tint, while any desired color can be given to it as desired by the addition of suitable coloring materials. Altogether, Mr. Ransome may be said to have created a new branch of industry of value alike to architects, ironmasters, and cement makers, and we are not surprised to learn that he is meeting with the co-operation of many of our leading men interested both in our iron and cement manufacture.—*Engineering.*

The Iron Crisis and its Lesson.

At a time when the iron industry, by far the most important of English manufactures, seems fast relapsing (notwithstanding fitful gleams of activity) into the critical position out of which it only emerged some eight months ago, it is clearly well worth our while to attentively examine our position and see if there is any prospect of mending it.

We have had more than enough of rosy prospects and pæans over the good things that are to come in the future, but are unable to fill the exchequer in the present. The most mischievous things in the world are agreeable illusions, and the best service is to expose them promptly. That we can look to any concurrence of favorable circumstances, bringing about a proximate renewal of the brief season of prosperity and high prices, which came upon us with bounds and "booms" in the latter part of last year, seems to the unbiassed observer in the highest degree improbable. America has been lately looked to as being, and likely to continue to be, our best customer for iron and steel, and the American demand is the sheet-anchor of our optimists; but that the working blast-furnace capacity of America, with her 400 furnaces in blast, is now very nearly, if not quite, abreast of all demands from American iron consumers seems indisputable; while it is also pretty clear that the Bessemer and open-hearth steel production of the United States will, in 1881, be not far, if at all, short of fifteen hundred thousand tons. The works of the Pittsburgh Steel Company and the St. Louis Works, with the extensions of the North Chicago, Scranton, Pennsylvania and the Edgar Thompson Companies will, without the new open-hearth plants now building, be alone equal to an increased product of at least 300,000 tons, and probably 400,000, tons of steel a year, while the new open-hearth furnaces will add a further 250,000 tons to the supply, so that clearly this is not an exaggerated estimate. Now, the rail requirements of the States for 1880-81 are not, by the most competent observers, expected to exceed 1,400,000 tons. It is therefore evident that unless some new feature arises in the calculation there is not much to be hoped for in the way of rail orders from the States during the coming year. Certainly the demand for iron rails will not be renewed. There remain only the home, European and colonial markets. But here we are brought face to face with another danger. We have been so long accustomed to consider our position as makers of cheap iron and steel unassailable, that we have perhaps allowed ourselves to slacken speed in the technical race, while our opponents have been straining every nerve to cheapen production, and availing themselves of every improvement that holds out a promise of economical results. It is certain that unless we bestir ourselves we may find Continental steel makers underselling us in neutral markets to a far greater extent than has hitherto been regarded as possible. In Italy and Spain and Holland we have already had to encounter severe competition from German and Belgian and even French makers. Let us by all means open up new markets in China and Japan, Turkey and Persia; but while thus going far afield it will not do to neglect what is nearer home. If the tron trade of England is to regain a position of prosperity it must, before all, devote itself to economy in production, and not sit quietly by and trust to Providence and a rise in

the markets. In pig iron making it is generally admitted that, in our newer districts at least, such as Cleveland, we are in the front rank for technical and economical efficiency; though, even here, the Americans, with their 1100 tons per furnace per week have surpassed anything we have yet done, and the Eastern France and Belgian and German makers are pushing ahead both in outputs, such as the 750 tons per furnace per week which is not uncommon in Luxembourg, and in economy of fuel. There are now several districts in Europe where pig is made as cheaply as in Cleveland, and that to the amount of some hundreds of thousands of tons per annum. It must, however, be admitted that the margin for economizing in blast-furnace practice is not large, and that, with the general adoption of the regenerative stove, we are doing much to minimize that margin. When we come, however, to the conversion of pig iron into malleable products, the matter is quite otherwise. At the present time it is best boldly to face the fact that the main, if not the only, direction in which economy of manufacture is to be looked for is in the substitution of steel for iron in every department. It cannot be too clearly understood that with modern appliances, which admit of readily producing from a pair of Bessemer vessels 80,000 to 150,000 tons a year, or with a pair of large Siemens or Pernot furnaces 20,000 tons a year, it is very much cheaper to convert a ton of pig into steel or ingot iron than into puddled iron. The elements of the calculation are simple. The two great factors of cost in the conversion of pig into malleable iron are labor and fuel. In each of these items the costs of a well-appointed Bessemer work, with a good system of boilers and economical engines, are far less than half of those in a puddling furnace. The fuel consumed in the Bessemer process is indeed a mere fraction of that consumed in puddling, while the resulting metal is unquestionably far better for every purpose than anything that can be turned out by the puddler. Yet we find almost every one of our leading competitors doing more—taking account of their crude iron manufacturing capacity—than ourselves, in substituting steel plant for the wasteful and obsolete puddling furnace. To illustrate this we may take the case of America, France, Belgium and Germany. The make of pig iron in 1879 in the United States was about 2,700,000 tons. The capacity of their new steel plant, according to Mr. Swank, is 570,000 tons, of which 330,000 will be Bessemer. In other words, their new Bessemer steel plant is now capable of dealing with one-eighth of their total production of pig iron. Moreover, their total steel-making capacity for 1881 will be (as we have seen) at least 1,500,000 tons, that is, they can more than convert one-half of their total pig production into steel.

In France the new Bessemer works of Longwy, de Wendel, Denain and the Meuse, alone will have a capacity of 200,000 tons, without reckoning the large open-hearth extensions at St. Chamond, Terrenoire, and elsewhere. But the total product of pig iron in France is only 1,300,000 tons, so that our neighbors, at whose claims to be a great and enterprising iron making people we are accustomed to sneer, are preparing for the change by building new Bessemer works, which will take at least one-seventh of their total make of crude iron. Belgium is erecting new Bessemer plant which will have a capacity of over 100,000 tons, or say one-fourth her total makes of pig iron.

Lastly, notwithstanding the almost crushing disasters which overtook her iron trade two years ago, we have Germany, with a pig-iron production of 1,900,000 tons, not only increasing her open-hearth capacity, but building at least four new Bessemer works, to work up her cheap phosphoric irons into steel. The capacity of these works may be taken as at least 150,000 tons, which represents about one-twelfth of her pig iron production. In England we have four new vessels building at Bolckow, Vaughan's works, two at Erimus, and two at Darlington, and one at Rhymney, with a total capacity, according to Mr. Jeans, of say 155,000—we do not count the Carnforth plant, which is really an old one, though it has never been at work. The same remark indeed also applies to the Darlington plant, which is actually only a part of Bolckow-Vaughan's old Gorton plant, and therefore not a real addition to our steel works, but merely a change of locality of an old work. This correction reduces the productive capacity of our new Bessemer plant to 125,000 tons, or in other words our new Bessemer plant will not convert one-fiftieth of our total make of over six and a quarter million tons of pig.

It is therefore clear that of all great iron-making countries we are at present the slowest in enlarging our productive capacity by the most economical and advantageous of all metallurgical processes. In fact, even Austria, with her four new ten-ton converters, which alone could convert at least a seventh of her make of crude iron, is far ahead of us in enterprise. But it may be urged that our existing Bessemer plant was far from being utilized in 1879, and why then should we build more; and secondly, that the large initial expenditure to erect a Bessemer plant is a serious obstacle when the profits of the trade are so precarious and small, and trade is so bad as it is at present. Both these seemingly plausible pleas, however, are fallacious. The existing British Bessemer plant that was not fully used in 1879, was only not used because it was old and badly arranged or badly placed. No better evidence of this can be afforded than the fact that the idle plants were, with one exception, those of the earlier days of the Bessemer industry when 200 tons per pit per week was thought an enormous output, and all arrangements were made in accordance with that view. To expect a Bessemer plant built more than a dozen years ago to compete successfully with those of to-day, when we consider the enormous progress the Bessemer process has made in the interval, would be utterly unreasonable. It is therefore not to be wondered at that some of the old plants with their three or four hundred tons per week capacity, should have been withdrawn from competition with the more modern plants which, costing comparatively little more, have four times their capacity. A modern ten-ton Bessemer plant of the Holley type, costing from £30,000 to £45,000, according to locality, has been proved capable of producing at least 140,000 tons a year, and would probably make much more, and is without question the cheapest iron making plant in the world. £40,000 seems a large sum, but when we find the interest and sinking fund on this capital amounts to less than 9d. per ton on our product, while it appears in addition that the ironmaking value of each man and each ton of coal is increased many fold in comparison with its utmost possible effect in puddling, we see what the President of the Iron and Steel Institute means by his assertion that the Bessemer vessel is the cheapest converting apparatus in the world. There is, however, one other limitation which has hitherto done more than anything else to arrest the progress of steelmaking and that has been the presence of phosphorus. So long as we were confined to the use of an insignificant fraction of our pig iron for steelmaking there was an obvious limit to expansion. But the final and complete success of the Thomas-Gilchrist dephosphorizing process has removed the last bar to an indefinite extension of our steel trade; and, if we would not meet the fate of laggards in the industrial race, we must make haste to bring our steel producing capacity into closer approximation with our crude iron production. That we have sufficient ground for assuming that the lime process is an economical success, as well as a technical one, will probably be recognized by those who have learnt from our foreign columns from week to week the remarkable development which this process has attained on the Continent—where, after a protracted trial at the leading Continental works, not only have these finally adopted it, but at least seven or eight new works are being built for its employment. Whether, as its extreme advocates assert, it will cost no more than the ordinary Bessemer process, or whether, as its interested opponents maintain, the actual working costs will exceed by seven or eight shillings the normal Bessemer costs, does not much signify for our purpose; since it is clear that, for the past twenty years, the difference between hematite and phosphoric pig has always exceeded 13s., and averaged about 30s. We have specially mentioned the Thomas-Gilchrist process because it is, as far as we know, the only direct dephosphorizing process, which has obtained any success at all; certainly no other has so far been employed for the manufacture of over 20,000 tons of steel. The Krupp or Bell process has, however, of the indirect processes, though not applicable to the Bessemer operation, in preparing pig for treatment in the open hearth furnace—obtained a certain degree of development and success. It appears, however, that it has been entirely abandoned in Europe, though it is, or speedily will be, in work in America. It will be interesting to observe the relative success of the direct-lime (or Thomas-Gilchrist) Siemens process, which, we understand, has already been practiced considerably in France, and will soon be in operation in America and England; and the indirect-ore or Bell-Krupp-Siemens process, which will unquestionably have a fair trial in the States, under Mr. Holley's auspices. How great is the confidence of French ironmasters in the technical future of dephosphorizing is shown by the fact, announced by us some weeks since, that M. Schneider and his associates, whose experience of the lime process is very considerable, they being, we believe, among Mr. Thomas's earliest licensees on the Continent, have already contracted for delivering nearly a quarter of a million of tons of steel rails, the greater part of which must necessarily be of dephosphorized steel. It is not, however, into rails only (or even chiefly), but into angles, plates, girders, and merchant iron of every description, that we must look to transforming our steel. It is very certain that for all these purposes steel, and cheap steel, will be wanted in immense quantities, and iron will not be accepted by foreign customers, if Continental and American makers are able to supply them in steel cheaper and better than we can in iron. Unless we wish to sink as ironmakers to the position of hewers of coal and makers of pig iron for other nations, and nothing more, we must speedily recognize, in a practical English way, the fact that steel is not only superior to iron, but, when made by good plant on a good system, also cheaper to produce. This we take to be the lesson of the times, and the sooner we master it the better.—*Iron.*

The Gas Company of Springfield, Mass., has contracted with R. F. Hawkins for two large boilers to meet the demand of additional consumers of steam heat next winter. This will make six boilers in use next season, and more will be added if required.—*Engineering News.*

THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

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THURSDAY, SEPT. 16, 1880.

Official Report of Examinations of Gas for two Weeks ending Sept. 11, 1880, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

1880. Aug.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
		†	*	†	‡	*	†
30		23.87	19.66	25.83	20.16	18.38	27.92
31	Between	24.20	19.28	26.82	20.99	18.28	28.82
Sept. 1	9.30 A.M. and 1 P.M.	24.22	18.77	26.25	20.88	18.45	27.40
2		24.42	18.04	26.73	20.77	17.95	29.34
3		25.38	18.62	27.10	20.69	18 02	28.73
4		24.00	19.08	28.22	20.73	18.16	28.10
	Average	24.35	18.91	26.82	21.32	18.20	28.22
6		24.36	19.44	27.72	20.63	18.47	28.30
7		24 28	20.17	28.12	20.86	18.91	28.22
8		23.81	19.40	29.23	20.76	18.80	29.34
9		24.13	20.25	28.44	21.26	18.90	28.41
10		24.30	19.51	28.65	21.02	18.59	28.63
11		24.15	19.75	28.21	20.86	18.50	28.55
	Average	24.17	19.75	28.39	20.89	18.69	28.57

* Five foot lava tip with check.
† Bray's slit union, No. 7.
‡ Bray's slit union, No. 6.

E. G. LOVE, Gas Examiner.

Gas Suffocation.

TORONTO, Sept. 6.—A case of quick death, through the agency of gas, occurred on Friday night. Thos. Congodan, an employee in the De la Salle Institute, blew out his gas before going to bed, and during the night was suffocated, being found dead in his bed on Saturday morning.—Hamilton (Ont.) *Spectator*.

An Improved Photometer.

An improvement on the Bunsen photometer has been devised by Herr Tœpler, and it is no longer necessary to use but one eye or that the observer take a certain determined position. The ordinary thin sheet of paper with the oil spot is replaced by two thin sheets of parchment paper placed one on each side of a stout sheet of paper perforated by a hole about an inch in diameter. The sheets are stretched on a frame between two sheets of clear glass. When the lights are properly opposed, the hole in this arrangement disappears, just as the oil spot does in the old device, but with much less inconvenience to the observer.

Gas Notes.

[From "Sanitary Engineer."]

The City Council of Quebec, as a matter of economy, decided to cut off the street lamps. Fifty attempts at burglary during the few nights following brought them to their senses, and the lamps were lighted in a hurry.

Of the 163 gas companies in the United States using oil as a material, it is said that 57 have changed back to coal gas and three have failed. The North Adams Co. tried oil for two or three years, and lost $10,000 in the experiment.

The Russian steamer *Czarewitch*, the swiftest mail boat on the Caspian Sea, has employed with great success the refuse of petroleum oil as fuel. It is blown into spray by a jet of steam, and is ignited inside of the furnace.

The Wolverhampton (Eng.) magistrates have held that carts loaded with refuse gas lime are not liable to pay toll on passing over turnpike roads, on the ground that the material was, in fact, manure, and was only intended for use as such.

Destruction of Cast Iron Pipes.

An unusual case of deterioration in cast iron gas pipes is reported to have been observed lately at Saarbrucken. The pipes referred to had been laid for ten years, and when removed were found converted into a soft substance which could be cut with a knife, and on analysis was found to contain only 52 per cent. of metallic iron. The pipes were laid in channels cut in soft sandstone, filled in with ashes from locomotives, and the coal which produced these ashes was from the Saarbrucken basin, and was relatively rich in sulphur. The destruction of the pipes is believed to have been due to the action of the sulphur contained in the ashes, combined with the oxygen--this view being supported by the fact that the substance into which the pipes had been changed contained 1⅓ per cent. of sulphuric acid.—*American Machinist.*

Prices of Gas Coal.

The following are the prices at which the companies mentioned are shipping coal:

	New York.	Baltimore.	S. Amboy
Penn.....	$5.25	$4.10	$4.80
Scott's Youghiogheny..	5.00	3.75	
Montauk.....	5.00	3.70	
Newburgh Orrel.....	5.00	3.75	
Tyrconnell	5.00	3.75	
Despard.....	5.00	3.75	
West Fairmount.....	5.00	3.75	

To give some idea of the relative prices at the East and the West we give the following quotations of coal furnished by the Fort Pitt Coal Company:

At Pitsburgh, f.o.b. cars....	$1.30	per ton of 2000 lbs.
At Cleveland, f.o.b. cars....	2.90	" "
At " f.o.b. vessels	3.05	" "
At Buffalo, f.o.b. cars..	3.55	" "
At Chicago, f.o.b. cars	3.60	" "
At Indianapolis, f.o.b. cars.	3.00	" "

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
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34 PINE STREET, NEW YORK CITY.
SEPTEMBER 16, 1880.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	*Par.*	*Bid.*	*Asked.*
Gas Co.'s of N. Y. City.				
Central.....	466,000	50	60	70
Harlem.....	1,800,000	50	70	75
" Bonds	170,000			103
Manhattan.....	4,000,000	50	189	193
Metropolitan.....	2,500,000	100	138	143
" Scrip ...	$1,000,000	...	100	103
Mutual.....	5,000,000	100	70	73
" Bonds, gold.	900,000	1000	100	—
Municipal.....	1,500,000	100	160	170
" Bonds	750,000		106	110
New York.....	4,000,000	100	104	105
Northern.....	270,000	50	—	100
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	106	110
Citizens.....	1,200,000	20	60	65
" S. F. Bonds.	320,000	1000	100	105
Fulton Municipal.....	1,500,000	100	70	80
Peoples.....	1,000,000	10	35	38
" Bonds.....	290,000	...	90	95
" Scrip	250,000	...	75	85
Metropolitan.....	1,000,000	100	55	65
Nassau.....	1,000,000	25	40	50
" Ctfs.....	700,000	1000	85	95
Williamsburgh	1,000,000	50	65	70
" Scrip		...	98	103
Kings Co.....	135,000	100	60	70
" Bonds.....	40,000	—	—	—
Union Co. E. N. Y...		25	—	50
Richmond Co., S. I.	300,000	...	75	80
Out of Town Gas Companies.				
Bath, Maine.....	70,000	100		
Buffalo Mutual, N.Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md.....	2,000,000	100	185	190
" Ctfs., gold	1,000,000		—	103
Bayonne, N. J.....		100		90
Brockport, N. Y.....	25,000	100	...	80
Citizens, Newark.....	918,000	50	85	90
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			125	—
Cincinnati G. & C. Co.				190
Consolidated, Balt.			89	90
" Bonds....			109	110
Derby of Conn.....	160,000	100	60	80
East Boston, Mass...		25	114	120
Elizabethtown, N. J.	300,000	20	—	130
Fort Wayne, Ind.....		100	...	—
Hannibal, Mo.....	100,000	100	95	100
Hartford, Conn.....	700,000	25	140	144
Hempstead, L. I.....	25,000	100	...	—
Halifax N. S.....	400,000	40	148	150
Hamilton, Ontario...	150.000	40	117½	
Jersey City	750,000	20	150	160
Jamaica, L. I.....	25,000	100	...	—
Jacksonville, Ill.....	120,000	50	100	...
Lewistown Maine...	400,000	100	70	80
Laclede St Louis Mo.	1,200,000	100	100	103
New Haven, Conn...		25	120	140
Oakland, Cal.....			35	36
Peoples, Jersey City		...	50	60
" " Bds.				5
Plainfield, N. J.....	80,000	100	—	105
Perth Amboy		25	—	95
Pittsfield, Mass.....			120	130
Rochester, N. Y.....		50	70	80
" Citizens		100	50	60
Rondout & Kingston			75	80
St. Louis Missouri..	600 000	50	250	254
Stillwater, Minn.....	50,000	50	—	26
Saugerties, N. Y.....	15,000	100	95	100

San Francisco Gas-Co., S. Fr'isco Cal.			77	79
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C.	1,500,000	20	200	—
" Scrip	500,000	20	100	110
Woonsocket, R. I.	150,000	100	80	...
Wilmington, Del.		50	174	...
Yonkers		50	—	70
Montreal, Canada	2,000,000	100	139	140

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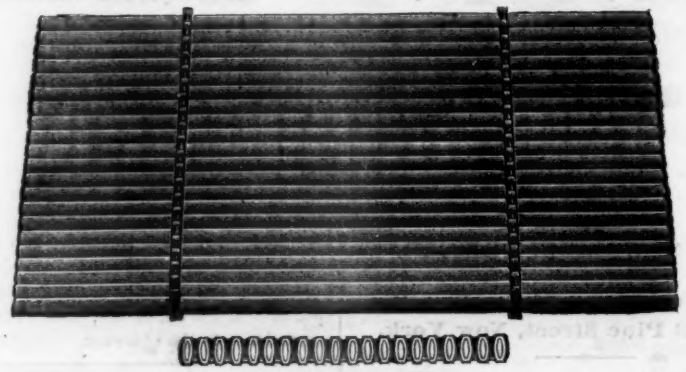

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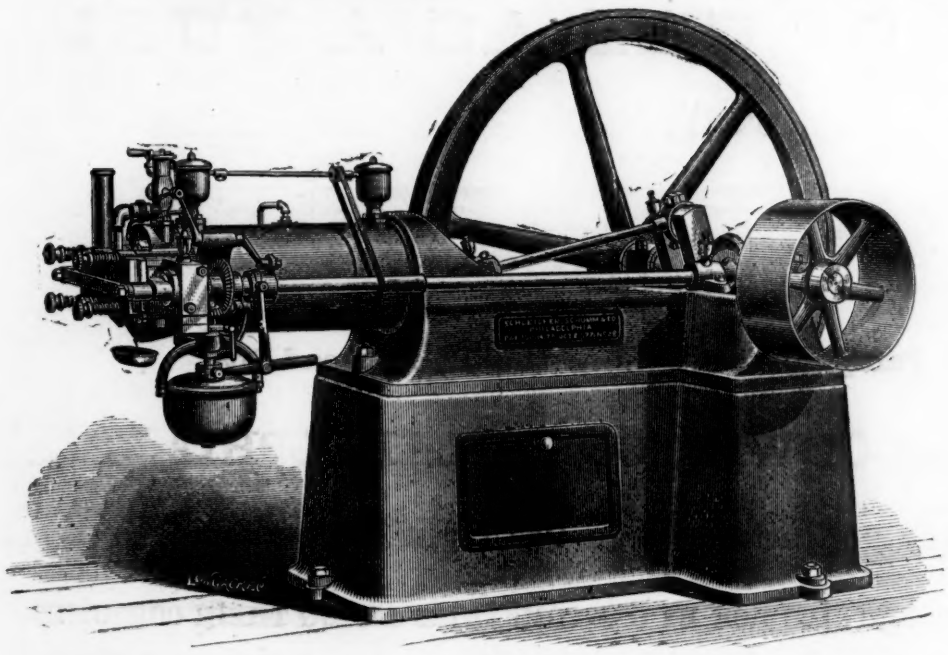

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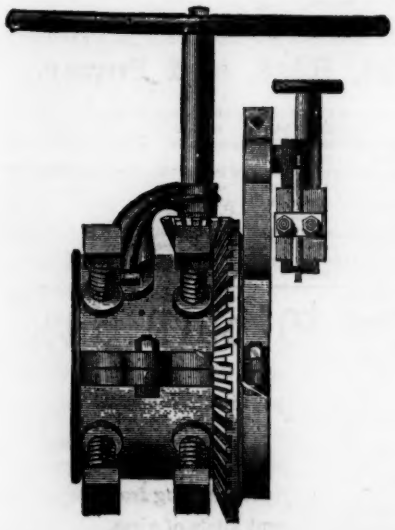

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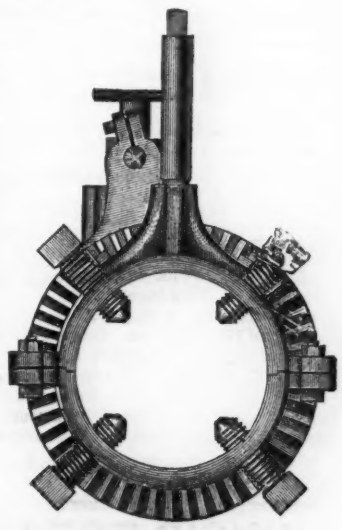

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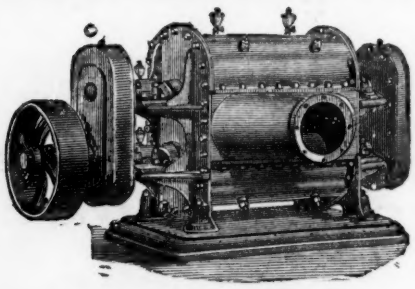

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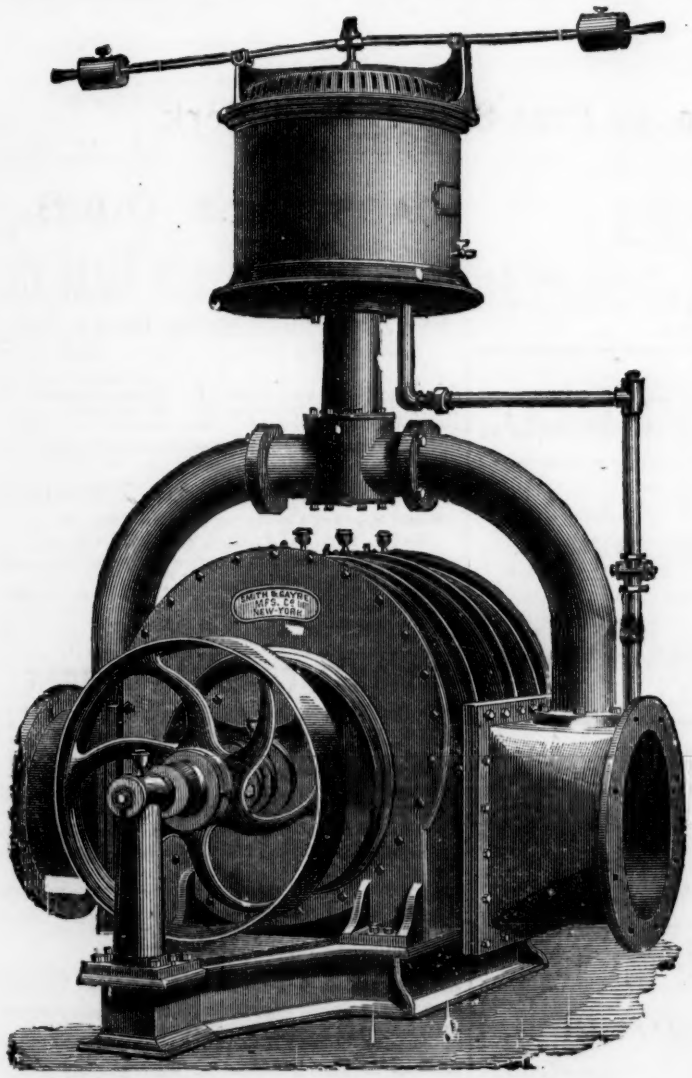

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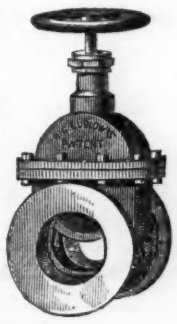

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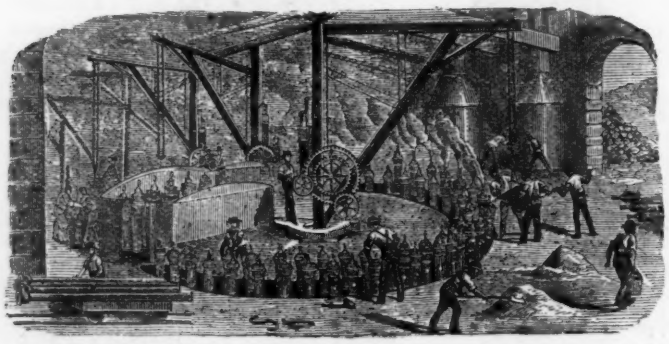

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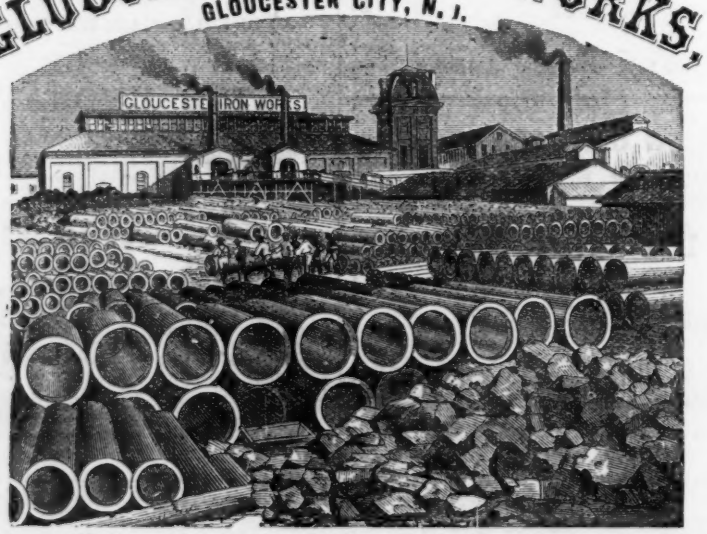

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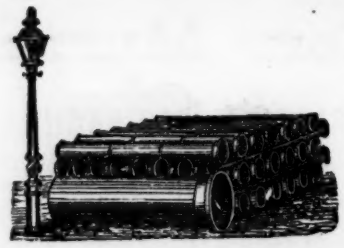

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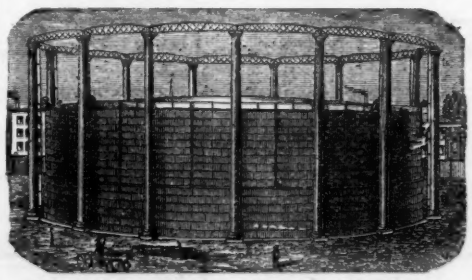

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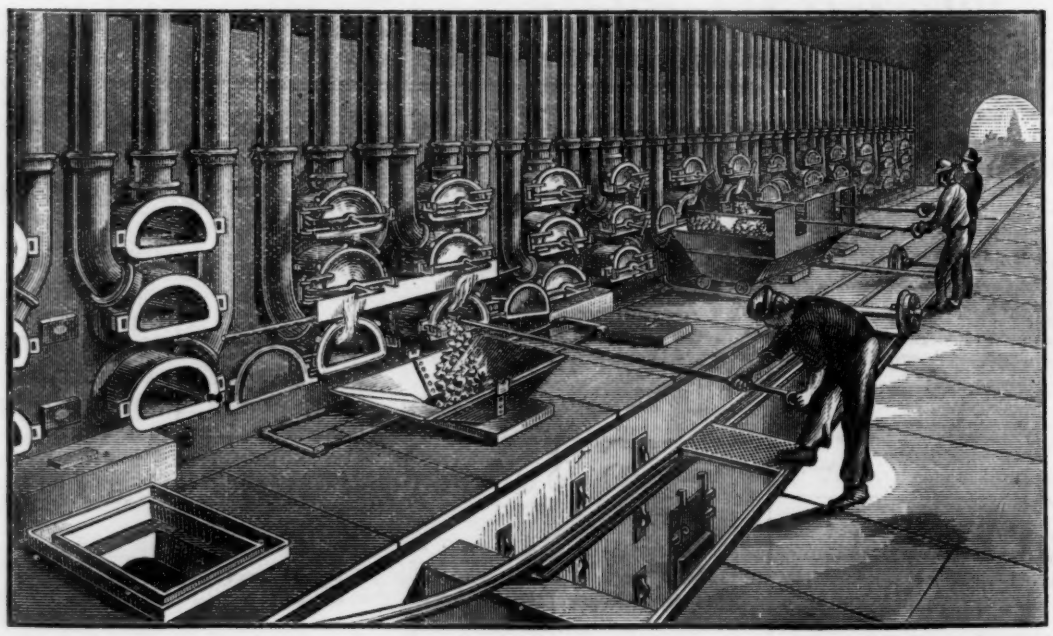

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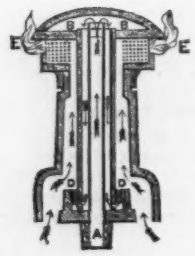

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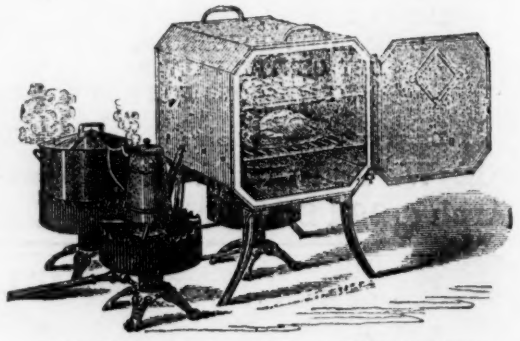

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